WATER RESOURCES DEVELOPMENT PROJECT

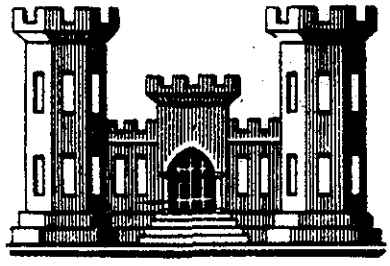
POINT JUDITH

RHODE ISLAND

DESIGN MEMORANDUM NO. 2

GENERAL DESIGN

(INCLUDING SITE GEOLOGY, AND EMBANKMENT AND FOUNDATIONS)



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

JULY 1966

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

IN REPLY REFER TO:

NEDED-D

22 July 1966

SUBJECT: Water Resources Development Project - Point Judith, Rhode Island - Design Memorandum No. 2 - General Design

TO: Chief of Engineers
ATTN: ENGCW-E

There is submitted herewith, for review and approval, Design Memorandum No. 2 - General Design (including Site Geology and Embankments and Foundations), for the Water Resources Development Project, Point Judith, Rhode Island, in accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

JOHN Wm. LESLIE
Chief, Engineering Division

Incl (10 cys)
Des Memo No. 2

WATER RESOURCES DEVELOPMENT PROJECT

POINT JUDITH
RHODE ISLAND

DESIGN MEMORANDUM NO. 2

GENERAL DESIGN

INDEX TO DESIGN MEMORANDA

No.	Title	Date Submitted	Date Approved
1	Hydrology and Hydraulics	1 Jul '65	5 Aug '65
2	General Design (including Site Geology and Embankments and Foundations)		
3	Concrete Materials	30 Sep '65	2 Nov '65
4	Real Estate		
5	Breachway Structure & Walls		

WATER RESOURCES DEVELOPMENT PROJECT

POINT JUDITH
RHODE ISLAND

DESIGN MEMORANDUM NO. 2

GENERAL DESIGN

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF PLATES

Plate No.	Title
2- 1	General Plan
2- 2	Plan and Profile No. 1
2- 3	Plan and Profile No. 2
2- 4	Plan and Profile No. 3
2- 5	Plan and Profile No. 4
2- 6	Plan and Profile No. 5
2- 7	Plan and Profile No. 6
2- 8	Plan and Profile No. 7
2- 9	Plan and Profile No. 8
2-10	Plan and Profile No. 9
2-11	Plan and Profile No. 10
2-12	Typical Sections No. 1
2-13	Typical Sections No. 2
2-14	Typical Sections No. 3
2-15	Breachway - Profile - Details
2-16	General Plan of Explorations
2-17	Record of Explorations No. 1
2-18	Record of Explorations No. 2
2-19	Plan & Record of Borrow Exploration No. 1
2-20	Plan & Record of Borrow Exploration No. 2
2-21	Grain Size - Parameters of Borrow Materials
2-22	Detailed Project Schedule

WATER RESOURCES DEVELOPMENT PROJECT

POINT JUDITH
RHODE ISLAND

DESIGN MEMORANDUM NO. 2

GENERAL DESIGN

A. PERTINENT DATA

1. Purpose — Water Resource Development, consisting of Hurricane Protection, Beach Erosion Control, and Navigation Improvement.

2. Location

State	Rhode Island
County	Washington
Towns	Narragansett & South Kingstown
Villages	Galilee & Jerusalem
Ocean	Block Island Sound - Atlantic

3. Drainage Areas

Saugatuckett River	16.7 square miles
Upper Pond	9.7 square miles

Pondage Areas at Elevation 10.0 MSL

Potter Pond	560 acres
Point Judith Pond	2,250 acres
Upper Pond	280 acres

4. Streamflow

There are no streamflow records for the Saugatuckett River. The calculation for streamflow is explained in approved Design Memorandum No. 1, "Hydrology and Hydraulics".

5. Beach Erosion and Hurricane Protection West of Breachway

✓ a. Earth & Rock Dike

Type	Earth, with rock slope protection
Length	✓ 400+ feet
Top Elevation	16.0 feet
Top Width	10.0 feet
Slopes	Ocean Side - 1 on 3 Land Side - 1 on 2.5

5. Beach Erosion and Hurricane Protection West of Breachway (Cont)

b. Earth & Rock Dike

Type	Earth and rockfill, with rock slope protection
Length	2,800 feet
Top Elevation	20.0 msl
Top Width	10.0 feet
Slopes	Ocean Side - 1 on 3 Land Side - 1 on 2.5

c. Earth & Rock Dike

Type	Earth, with rock slope protection
Length	1,100 feet
Top Elevation	20.0 msl
Top Width	20.0 feet
Slopes	1 on 3

d. Rock Revetment

Type	Sand Fill, with rock slope protection
Length	650 feet
Top Elevation	20.0 feet
Top Width	10.0 feet
Slopes	Ocean Side - 1 on 6 Land Side - 1 on 3

e. Dune and Beach

Type	Sand Fill, with berm and new beach slope
Length	4,350 feet
Top Elevation	17.5 feet
Top Width	25. feet
Side Slopes	
Dune	Ocean Side - 1 on 5 Land Side - 1 on 5
Beach	1 on 20
Berm Elevation	12.5 msl - 100 feet in width

f. Groins

New	2
Rebuilt	5
Type	Rock

5. Beach Erosion and Hurricane Protection West of Breachway (Cont)

f. Groins (Cont)

Length	400. feet
Top Elevation	Varies
Width	Varies
Slopes	1 on 2.5

g. Breachway

Length (overall)	2,000 feet
Navigation Opening	150 feet
Length - Rock Dike	900 feet East 750. feet West
Concrete Structure Incl. Navigation Opening	350. feet
Top Width, Rock Dikes West and East	10 & 15 feet
Concrete	Varies
Rock Sill Elevation	-24.5 feet msl
Rock Sill, Side Slopes	1 on 4

h. Fender System

Type	Concrete and timber treated wood pile
Length	200 feet on each side of channel

6. Beach Erosion and Hurricane Protection East of Breachway

a. Bulkhead

Type	Sand fill with pre-cast concrete pile bulkhead
Length	1,956. feet
Top Elevation	22.0 msl
Top Width, Berm	Varies
Berm Width	5.0 feet
Berm Elevation	18.5 feet
Side Slopes	1 on 3

b. Dune and Beach

Type	Sand Fill, with ocean side berm and new beach slope
Length	1,800. feet

6. Beach Erosion and Hurricane Protection East of Breachway (Cont)

b. Dune and Beach (Cont)

Top Elevation	17.0 msl
Top Width	15.0 feet
Side Slopes	Dune - 1 on 5
	Beach - 1 on 15
Berm	Elevation 10.5 msl - 50 feet in width

c. Rock Dike

Type	Sand Fill with rock slope protection
Length	1,400 feet
Top Elevation	14.0 msl
Top Width	10.0 feet
Slopes	Ocean Side - 1 on 3
	Land Side - 1 on 2.5
Berm	Elevation 10.5 msl - 50 feet in width

d. Earth Dike

Type	Earth with rock slope protection
Length	700 feet
Top Elevation	14.0 feet
Top Width	10.0 feet
Side Slopes	Ocean Side - 1 on 3
	Land Side - 1 on 2.5

7. Navigation

a. Entrance Channel

Length	4,400 feet & 1,300 feet
Width	150 feet & 200 feet
Bottom Elevation	-21.45 msl

b. Inner Harbor Anchorage

Area	11 acres & 8 acres
Bottom Elevation	-11.45 msl -9.45 msl

c. Channel to Little Comfort Anchorage

Length	1,700 feet & 460 feet
Width	150 feet & 100 feet
Bottom Elevation	-11.45 msl

7. Navigation (Cont)

d. Little Comfort Anchorage

Area	8	acres
Bottom Elevation	-9.45 (8ft)	msl

e. Snug Harbor Channel

Length	2,200	feet
Width	100	feet
Bottom Elevation	-9.45 (8ft)	msl

f. Snug Harbor Anchorage

Area	5	acres
Bottom Elevation	-9.45 (8ft)	msl

g. Wakefield Channel

Length	19,800	feet
Width	100	feet
Bottom Elevation	-9.45 (8ft)	msl

h. Wakefield Anchorage

Area	13.0 (includes 6 acres existing)	acres
Bottom Elevation	-9.45 (8ft)	msl

8. Relocations

a. Roads

Succotash Road (to be accomplished by the State)

b. Utilities

(1) Telephone	1,000	feet
(2) Electric	1,000	feet
Water Supply	5	each

c. Sewage Disposal Systems	5	each
d. Drainage System	1	each

9. Principal Quantities

Compacted Earth Fill	38,000	c.y.	
Excavation	106,000	c.y.	
Fill, (Sand)	743,000	c.y.	
Gravel Bedding	44,300	c.y.	
Rock Armor	92,800	tons	
Stone Protection	40,000	tons	
Bedding Stone	61,200	tons	
Sand Fence	7,700	l.f.	
Concrete Tremie	5,300	c.y.	
Mass Concrete	3,100	c.y.	
Prestressed Concrete Pile	2,550	l.f.	(beach house & bulkhead wall)
Fender System	400	l.f.	
Wood Pile	560	each	

10. Project Features

	Cost
Lands and Damages	$ 985,000.00
Dredging - Hydraulic	342,000.00
Dredging - Scow	562,000.00
Levees & Floodwalls	4,336,000.00
Engineering & Design	447,000.00
Supervision & Administration	428,000.00

TOTAL ESTIMATED PROJECT COST.....$7,100,000.00

TABLE I

WAVE HEIGHT COMPARISONS

Matunuck Beach	Assumed Erosion at Rock Toe	Depth of Water at Rock Toe After Erosion	Design Wave Height at Rock Toe	Design Homo #1 Wave Ht. at M.S.L.
Sta. 0+00 to 3+50	2.0'	4.5	3.5	2.0
" 3+25 to 31+00	4.0	6.5	5.0*	9.8
" 31+00 to 43+00	4.0	8.5	7.0	9.8
" 43+00 to 50+00	0	14.5	11.0	10.0
Breachway Control Section				
Sta. 102+70 to 104+00	2.0	6.5	5.0	5.1
" 104+00 to 104+50	2.0	8.0	6.0	5.1
" 104+50 to 105+00	0	13.0	10.0	5.1
" 107+25 to 107+75	0	13.0	10.0	5.1
" 107+75 to 110+00	4.0	6.5	5.0	2.7
" 110+00 to 112+00	2.0	2.0	2.0	2.7
Sand Hill Cove				
Sta. 157+00 to 172+50	4.0	4.0	3.0*	9.0
" 172+50 to 175+50	0	4.5	3.5	2.0
" 175+50 to 178+50	0	2.5	2.0	2.0

* extra wide beach in front of rock dike.

"a. Provide without cost to the United States all lands, easements, rights-of-way, and spoil-disposal, pondage, and borrow areas necessary for the construction of the project and for subsequent maintenance of the navigation Features, when and as required;

"b. Accomplish without cost to the United States all alterations and relocations of sewage and drainage facilities, buildings, utilities, highways, and other structures made necessary by the construction;

"c. Bear 31 percent of the total first cost, a sum presently estimated at $2,200,000, to consist of the items listed in subparagraphs a and b above and a cash contribution now estimated at $1,215,000 to be paid either in a lump sum prior to initiation of construction or in installments prior to commencement of pertinent work items, in accordance with construction schedules as required by the Chief of Engineers, the final apportionment of which cost to be made after actual costs and values have been determined;

"d. Hold and save the United States free from damages due to construction of the project and subsequent maintenance of the navigation features;

"e. Maintain and operate all the works after completion, except the navigation channels, anchorage area, and aids to navigation, in accordance with regulations prescribed by the Secretary of the Army;

"f. Assure continued public ownership of the above upon which Federal participation in beach erosion control is based and its administration for public use during the economic life of the project;

"g. Control water pollution to the extent necessary to safeguard the health of bathers;

"h. Provide and maintain without cost to the United States necessary mooring facilities and utilities, including additional public landings at Snug Harbor and Wakefield, with suitable supply facilities open to all on equal terms;

"i. Construct and maintain any bulkheads required for retention of dredged material discharged to spoil-disposal areas from the initial construction and subsequent maintenance of navigation features;

"j. Provide suitable facilities at East Matunuck State Beach to support the recreational development of the beach; and

"k. At least annually inform the public and those affected that the improvement will not provide any substantial protection from ocean surges higher in elevation than that which occurred in September 1938."

The present estimated cost of the project is $7,100,000. The present Federal share is $4,900,000 and the Non-Federal share is $2,200,000. The estimated Federal annual maintenance is $10,700 and the estimated Non-Federal annual maintenance is $92,800.

D. INVESTIGATIONS

4. PREVIOUS INVESTIGATIONS

a. Hurricane Report. An interim report on the Water Resources Development Project, Point Judith, Rhode Island, was submitted on 24 January 1962. This report covered the hurricane protection, a navigation study and a related beach erosion control improvement study. The hurricane study was made in partial compliance with authorization contained in Public Law 71, 84th Congress, 1st Session, adopted 15 June 1955. The navigation study was made in accordance with a resolution adopted 1 July 1949 by the Committee on Public Works of the United States Senate. The beach erosion control study was included because shore protection is the first line of defense against hurricanes and shore recreation; it is an essential part of the comprehensive development of this region. This study was authorized by Congress under the cooperative beach erosion projects.

b. Navigation Reports. The existing navigation project for Point Judith Harbor and Pond is set forth in Senate Document No. 15, 80th Congress, 1st Session, dated 11 February 1947. The authorized project was completed in 1950.

c. Beach Erosion. The beach erosion improvements authorized in 1949 under House Document Numbered 490, 81st Congress, 2nd Session, at Sand Hill Cove State Beach, were completed in 1955. No appropriation has been made for the beach erosion improvements at East Matunuck State Beach, authorized by the River and Harbor Act of 1960 and outlined in House Document Numbered 30, 86th Congress, 1st Session.

5. CURRENT INVESTIGATIONS

In order to determine the most practicable design for the project, basic data obtained in the previous studies were fully utilized. Additional studies were made as follows:

a. Studies for the project plan have utilized the basic data obtained from the previous investigations, new surveys, and additional subsurface investigations.

b. Hydrologic studies were made to determine the flood plain caused by interior runoff behind the protective works and the affect on pond levels behind the protective works.

c. Hurricane studies were made to review design stillwater levels, wind velocity and wave height.

d. Studies were made to review the armor protection for the structures.

e. Design Memorandum No. 1, "Hydrology and Hydraulics", was submitted and approved.

f. Design Memorandum No. 3, "Concrete Materials", was submitted and approved.

6. COORDINATION WITH OTHER AGENCIES

The following Federal agencies were requested to furnish their views on the project:

a. U. S. Department of the Interior, Fish and Wildlife Service.

b. U. S. Department of Commerce, Bureau of Public Roads.

c. Department of Health, Education and Welfare, Federal Water Pollution Control Administration.

d. U. S. Coast Guard.

The following state agencies were requested to furnish their views on the project:

a. Department of Agriculture and Conservation, Division of Fish and Game.

b. Rhode Island Department of Health, Division of Sanitary Engineering.

c. Rhode Island Department of Public Works, Division of Harbors and Rivers.

d. Rhode Island Development Council.

e. Rhode Island Department of Public Works, Division of Parks and Recreation.

The affected Towns of South Kingstown and Narragansett were also asked to furnish their views on the project.

The reports of each of the above agencies and towns are contained in Appendix B.

7. PUBLIC HEARINGS

Public Hearings were held at South Kingstown and Narragansett, Rhode Island, on 17 December 1958 and 6 June 1960, respectively, to give all interested parties an opportunity to express their views concerning the character and extent of the improvements desired, and the need and advisability of their execution. The 17 December 1958 hearing concerned improvements to the existing navigation project at Point Judith, but local interests requested that beach erosion control and hurricane tidal flooding protection for the area be investigated concurrently with the navigation improvement study. At the second hearing, the results of the combined study were presented; the majority favored a multi-purpose plan of improvements with proper consideration of its effects on the recreational, scenic and economic aspects of the area.

E. LOCAL COOPERATION

8. LOCAL COOPERATION

Local cooperation, as stated in paragraph 3 above, is required. Formal requests for local cooperation will be made after approval of the General Design Memorandum.

F. LOCATION OF THE PROJECT

9. LOCATION OF THE PROJECT

The project is located in the Towns of Narragansett and South Kingstown, Washington County, Rhode Island. It is approximately 40 miles south of Providence. It lies on the northeast side of Block Island Sound, which is exposed to the Atlantic Ocean.

10. DESCRIPTION OF THE AREA

The shore front can best be described as a barrier beach of glacial sands between the two eroding headlands of Point Judith and Matunuck Point. Included within the inland area are Point Judith Pond, Upper Pond, and Potter Pond, which are interconnected bodies of tidal water with an opening to the ocean through a stabilized inlet, "The Breachway", at the Villages of Jerusalem and Galilee.

The area includes extensive facilities for commercial fishing, sport fishing and recreational boating with residential development distributed along the coast line and shores of the ponds.

The principal year-round commercial activity is the fishing industry at Galilee. The fish dehydrating plant, the fisherman's cooperative, boat yards and suppliers operate year-round. During the

summer, additional boat yards and marinas provide facilities for recreational boating and sport fishing activity. Also, many small stores and restaurants supply the needs of the expanded summer population.

11. TIDES

Two high and two low tides occur each lunar day in the Point Judith area. At Matunuck and in the Point Judith Harbor of Refuge, the mean tide range is 3.1 feet, with mean low water 1.45 feet below mean sea level and mean high water 1.65 feet above mean sea level. Spring tides have an average range of 3.9 feet and a maximum range of about 6 feet. A maximum spring tide will reach an elevation 4.6 feet above mean low water (1.5 feet above mean high water). The time interval for a complete tidal cycle averages about 12 hours and 25 minutes.

At Galilee and Jerusalem, within Point Judith Pond just north of "The Breachway", and in the Upper Pond, the mean tide ranges are 3.0 and 2.9 feet, respectively. In Potter Pond, the mean tide range is 1.0 feet, while in the Potter Pond Channel at the highway bridge the mean tide range is about 1.5 feet. Maximum tidal currents are less than 1 knot in the entrance to the Harbor of Refuge between the breakwaters, but average 2.9 knots on the flood and 2.7 knots on the ebb through the entrance to Point Judith Pond at "The Breachway".

G. RECOMMENDED PROJECT PLAN

12. RECOMMENDED PROJECT PLAN

The recommended project plan is a multiple-purpose one, consisting of Hurricane Flood Protection, Beach Erosion Control, and Navigation Improvements. It commences on high ground at Matunuck Beach just west of Matunuck Beach Road and extends easterly, approximately three and one-half miles, crossing the existing navigation channel to Point Judith Pond, to high ground at Sand Hill Cove.

The plan provides for the restoration of the sand dunes, beach raising and widening, a breachway control structure, and navigation improvements. It is separable into four distinct parts: west of "The Breachway", "The Breachway", east of "The Breachway", and the Navigation Improvements. The segment west of "The Breachway" consists of the following: earth dike, rock dike, earth and rock revetment, and dune and beach fill. "The Breachway" consists of an ungated concrete control structure and an earth and rock fill dike. The segment east of "The Breachway" consists of the following: earth

dike, bulkhead, dune and beach fill, rock dike with beach fill, and earth and rock dike. The navigation improvements consist of the following: straightening and deepening the entrance channel, deepening the existing channel from "The Breachway" to Wakefield, as well as to Snug Harbor and to Little Comfort Island. It also provides additional anchorage areas at the Fish plant, and at Wakefield with new anchorage areas at Snug Harbor and at Little Comfort Island. The project requires the relocation of portions of Matunuck Beach Road and Succotash Road, with minor relocations of water and sewage facilities. The structures, improvement and relocations are discussed in detail in paragraphs 38 through 40. The various structures and the topography of the site are shown on Plate Nos. 2-2 and 2-15.

H. DEPARTURES FROM THE RECOMMENDED PLAN

13. DEPARTURES FROM THE AUTHORIZED PLAN

The development of detailed design studies including consideration of additional information resulted in modifications and changes from the plan, on which authorization was based. These changes are set forth below:

a. Succotash Road relocation was eliminated from the project at the request of the Department of Public Works, Division of Parks and Recreation and will be relocated by them.

b. At "The Breachway" structure, the width was made 150 feet at the sill elevation minus 24.45 feet below mean sea level to conform to the authorized channel width.

c. A rock dike with a sand fill interior zone was substituted for the concrete pile cut-off wall at the Galilee Beach Club because of construction problems of driving the concrete piles between the walls of the existing structures.

d. The top elevation of the bulkhead wall was made constant at 22.0 feet above mean sea level instead of varying from 22.0 to 20.0 feet above mean sea level.

I. HYDROLOGY

14. HYDROLOGY

The hydrologic design was based on a rainfall and watershed peak discharge frequency of a ten-year (10) return period concurrent with a peak hurricane induced tide inside the Point Judith Ponds.

The fresh water inflow raised the water level of Point Judith Pond approximately 0.4 feet over that caused by the salt water inflow alone.

More detailed descriptions of the hydrologic considerations are given in approved Design Memorandum No. 1, "Hydrology and Hydraulics".

J. TIDAL HYDRAULICS

15. HURRICANE TIDAL HYDRAULICS

The selected design stillwater elevations are 12.5 and 10.5 feet above mean sea level. These elevations represent the maximum water levels of hurricane flood waters in a 326-year period. At "The Breachway", the wave setup is smaller, the selected design stillwater level is 9.5 feet above mean sea level.

The design wave heights for the Point Judith Project are based on a significant wave height of 26 feet and a period of 12 seconds.

Additional details of the tidal hydraulics are set forth in approved Design Memorandum No. 1, "Hydrology and Hydraulics".

16. ROCK EMBANKMENTS

Most of the rock dikes will be constructed on the upper backslope of the existing beaches (backbeach), and the toe of the rock slopes will be a considerable distance from mean sea level. Therefore, the design wave selected was determined as the maximum that could be sustained at the toe of the rock slope. The design wave heights used to calculate the rock sizes are 0.78 times the depth of water at the toe of the rock slopes, after an allowance for erosion. These wave heights differ somewhat from the Hydrology and Hydraulics Design Memorandum, but the analysis has been approved by consultants of the Chief of Engineers' office. A summary of the differences in wave heights between the approved Design Memorandum No. 1 and estimates used in this memorandum is shown in Table 1 on the following page.

Although the breakwaters of the Harbor of Refuge will reduce the hurricane flood levels along the interior shoreline to elevation 10.5 feet above mean sea level, sizeable waves will enter the Harbor of Refuge through the entrance openings. After routing the seaward waves through the "equivalent gap openings", it was found that a wave height of 7.0 feet and a wave up to 12.0 feet could reach the breachway control structure through the west and east openings, respectively. However, since there is a short rock jetty on the easterly shore of the breachway entrance, it is doubtful if the full 12.0 feet wave height would reach the control structure from the east opening; therefore, a wave height of 10.0 feet was used in the breachway entrance channel for design purposes.

TABLE I

WAVE HEIGHT COMPARISONS

Matunuck Beach	Assumed Erosion at Rock Toe	Depth of Water at Rock Toe After Erosion	Design Wave Height at Rock Toe	Design Homo #1 Wave Ht. at M.S.L.
Sta. 0+00 to 3+50	2.0'	4.5	3.5	2.0
" 3+25 to 31+00	4.0	6.5	5.0*	9.8
" 31+00 to 43+00	4.0	8.5	7.0	9.8
" 43+00 to 50+00	0	14.5	11.0	10.0
Breachway Control Section				
Sta. 102+70 to 104+00	2.0	6.5	5.0	5.1
" 104+00 to 104+50	2.0	8.0	6.0	5.1
" 104+50 to 105+00	0	13.0	10.0	5.1
" 107+25 to 107+75	0	13.0	10.0	5.1
" 107+75 to 110+00	4.0	6.5	5.0	2.7
" 110+00 to 112+00	2.0	2.0	2.0	2.7
Sand Hill Cove				
Sta. 157+00 to 172+50	4.0	4.0	3.0*	9.0
" 172+50 to 175+50	0	4.5	3.5	2.0
" 175+50 to 178+50	0	2.5	2.0	2.0

* extra wide beach in front of rock dike.

Rock sizes were determined by the WES Formula as described in TR No. 4 and EM 1110-2-2904. A Kd of 2.8 was used to provide minimum maintenance on the flanks and a Kd of 3.0 was used at the breachway structure because of the protected location. The unit weight of all the rock was assumed to be 165 lbs/cu. ft. The thickness of the rock armor is based on the minimum size and consists of two layers, placed in a pellmell pattern to assure maximum roughness. Each unit should approximate a cube, with three dimensions of about equal length. The armor layer will not be filled in with chinking stone. The thickness of the rock bedding is also in two layers and about 1/20 the weight of the armor units.

The filter material can be either of rock weighing 1/20 of the weight of the rock bedding or gravel bedding. Gravel bedding will be used.

Table II on the following page summarizes the minimum rock sizes at the stationing indicated.

The embankment slopes are as shown on the typical sections and were designed for economy and accessibility, as well as stability of the structure and minimum run-ups.

The minimum crest width is the width corresponding to the combined widths of three cap rocks. However, a minimum width of 10.0 feet was selected to accommodate equipment that may be used for construction and/or maintenance. The weight of the rock armor on the crest is equal to the weight of the rock armor but placed in a single layer and may be chinked to provide a relatively smooth surface.

The back slopes are shown on the typical sections and consist of a protection layer and a bedding layer. Sizes were arbitrarily selected to fit within the thicknesses shown, as no appreciable overtopping forces are anticipated.

Due to the limited fetch of Point Judith Pond, the wave heights that could be generated from a reversal of the wind field was found to be a maximum of about three feet. The rock sizes on the back slopes of the breachway structure were selected as one-half the weight of the front slope rock armor to withstand any overtopping that may occur in the breachway area. The rock around the abutments is the same on both inside and outside slopes to provide added stability against the stronger hurricane currents caused by differential heads.

TABLE II

MINIMUM ROCK SIZES

Matunuck Beach	Kd	Armor	Bedding	Filter
Sta. 0+50 to 4+50	2.8	500 lbs.	50 lbs.	Gravel
" 4+50 to 32+00	2.8	500 lbs.	50 lbs.	Gravel
" 32+00 to 44+50	2.8	1 to 2 tons	100 lbs.	Gravel
" 44+50 to 51+42	2.8	2 to 3 tons	200 lbs.	Gravel
Breachway Control Area				
Sta. 97+50 to 106+82	3.0	1 to 2 tons	100 lbs.	Gravel
" 110+22 to 117+64	3.0	1 to 2 tons	100 lbs.	Gravel
Sand Hill Cove				
Sta. 160+00 to 174+00	2.8	150 to 500 lbs.	50 lbs.	Gravel
" 174+00 to 181+00	2.8	50 to 500 lbs.	50 lbs.	Gravel

Selected sizes and thicknesses are shown on typical sections (see Plates 2-12 to 2-14).

K. GEOLOGY

17. GENERAL

The shore of southern Rhode Island west of Narragansett Bay extends from Watch Hill, on the Connecticut border, eastward to Point Judith at the entrance to Narragansett Bay, a distance of 20 miles. What was once a large outwash plain consisting of gravel, sand, and inorganic silt, has been submerged and has been largely removed by marine forces, leaving fragments above mean sea level, between barrier beaches and coastal lagoons on the south and a resistant deposit of boulders and very sandy glacial till known as the Harbor Hill marina on the north. The moraine curves and extends into the sea at Watch Hill, where it forms the westernmost headland protecting a highly exposed, fragile string of beaches to the east. Point Judith, a separate till deposit, is the eastern promontory. Between these two prongs, the sand stretches and is delicately held seaward, in groin fashion, by a few lesser, resistant headlands. The headlands, left exposed by the loss of flanking sand through deflation and wave action, will be eroded rapidly, leaving offshore patches of coarse debris and a diminishing sand supply. The lesser headlands cannot protect the beaches from direct southerly storms in the manner in which they help prevent excessive longshore evasion; hence, occasional overtopping of the bars, destruction of dunes, and the formation of temporary breaches has occurred and will recur unless prevented by man-made structures.

18. SITE GEOLOGY

No bedrock is exposed along the 11-mile shoreline between Quonochontaug Point and Point Judith. There is a small rock exposure on the beach at Quonochontaug Point, but no exposure at Point Judith. Morainic materials extend southward to form the point from a large rock-controlled hill standing about 2 miles north of Point Judith. This morainic ridge can be said to resemble an immense jetty lying at the western entrance to Narragansett Bay, a jetty which is nearly flanked by the sea at its shoreward end where the Narrows and Pettaquamscutt Cove, at Narragansett, and Silver Lake and Point Judith Pond, at South Kingstown, form a nearly continuous arm of the sea. This arm, if completed, would make most of the township of Narragansett an island. The jetty-like peninsula serves an eastern terminal groin to a series of thin, low, bay-mouth bars or barrier beaches which extend from the controlling rock outcrops at Quonochontaug and isolate, or partially close-off, a series of ponds from Block Island Sound serving, in this sense, as a barrier beach. The only interruptions along the barrier bars are a till hill at Green Hill, about midway between Quonochontaug and Point Judith, and the residue of a nearly completely eroded till

hill at Matunuck Point. The latter is a last ditch bastion against the sea, preventing wide-spread destruction of the barrier beach between Green Hill and Point Judith, a stretch which brackets the area represented by this project.

19. SITE INVESTIGATIONS

Early planning efforts were directed towards investigating possibilities of establishing anchorage areas between Succotash Road and Point Judith Pond, thereby providing sand for raising elevations along the beach bars and nourishment for the beaches. Too much mud and fine sand were encountered in this area and efforts were redirected towards improving navigation facilities in the inner harbor and straightening the outer channel. Explorations for this survey phase of the investigations consisted of 16 drive sample borings. The record of these borings is shown on Plate 2-17. A complete plan of these explorations appears in the Point Judith Interim Report.

Explorations for final design thus far have consisted of 5 borings in the Harbor of Refuge and 10 borings in Point Judith Pond, to predetermine the nature of the materials to be dredged. Two foundation borings were made in "The Breachway" to determine the nature of the foundation for the structures at the navigational opening. Additional borings are being made in all of these areas to finalize the design. Additional explorations will be made in the Sand Hill Cove area where a dike will cross a marshy tract. Plans and records of current explorations are shown on Plates 2-17 and 2-18.

20. BORROW INVESTIGATIONS

Geological reconnaissance and sampling of exposures of sand throughout the territory surrounding the Point Judith area led to subsurface investigations in an area north of Ellis Flats in the Carolina, Rhode Island, USGS quadrangle. (See Plate 2-19). Explorations consisted of 9 drive sample borings and 21 hand auger borings. Locations and graphic logs are shown on Plates 2-19 and 2-20. Underlying sands in the area provided a close approximation to the requirements that the material have a median diameter of 0.4 mm. and a low coefficient of sorting as shown on Plate 2-21. Much of the stripping materials has been found to be suitable for use as beach fill above high water and it is planned to provide these materials for that purpose. Additional sand fill will come from dredging south of Snug Harbor, Point Judith Pond, and from the outer entrance channel in Harbor of Refuge. It is anticipated that about 500,000 c.y. of borrow will be provided from the Carolina area and that approximately 276,000 c.y. will be supplied from the dredging. Some of the materials in the channel north of Snug Harbor and the anchorage extension at Wakefield are suitable for beach placement or other use, but will be spoiled because of costs involved in

transferring them to the site since planned deepening is small and it involves a thin, skimming operation over long reaches. Borings indicate that some of the materials in the pond south of Snug Harbor, designated for hydraulic dredging also are unsuitable for beach placement. Additional explorations are being made to indicate which of these areas shall be incorporated in the initial bucket dredging and scowing out contract which will preceed the hydraulic dredging.

21. AVAILABILITY OF CONSTRUCTION MATERIALS

a. Earthen Borrow. Part of the underlying beach or artificial dune fills will consist of sands and gravelly sands from dredging outside "The Breachway". Fine sands and silty fine sands from dredging in lower Point Judith Pond will be used similarly. Additional fill, approximately 350,000 c.y., will be sand of controlled grain size hauled from the borrow area, distances ranging from 12 to 18 miles, averaging about 15 miles. In addition, approximately 150,000 c.y. of gravelly sand, comprising overlying material from the borrow area, will be hauled in for the remaining beach fill. Sandy, coarse gravels for bedding and filter materials are available in undeveloped sources 3 to 5 miles away from portions of the work west of "The Breachway" and within 10 miles of Galilee. Commercial sources of sandy gravel lie within 10 miles of all areas of the work. Suitable materials for the dikes also can be obtained within this haul distance.

b. Rock. Approximately 200,000 tons of rock for revetment and slope protection, ranging in size from 50 pounds to 4 tons will be required. Theoretical sizes for various reaches of the work vary greatly. An attempt has been made to group the size ranges so that existing stockpiles of granite in the Bradford-Westerly area, about 20 miles away, can be utilized with a minimum of processing and selection. An umlimited supply of excellent quality granite is available in that area. Limited local quarrying has been carried on within 10 miles of the site, but it is doubtful that local operation would be more economical.

c. Concrete Materials. Concrete and concrete materials are discussed fully in approved Design Memorandum No. 3.

L. FOUNDATION AND EMBANKMENTS

22. DISTRIBUTION AND DESCRIPTION OF FOUNDATION SOILS

a. General. The pertinent foundation soils along the proposed alignment consist generally of loose sands and gravelly sands. These solid form the existing beaches and dunes which are present for most of the alignment. The beaches merge into a badly eroded till hill near Matunuck Point. Concentration of boulders, blocks and remnants of concrete foundations from buildings destroyed during previous hurricanes occur in zones of tidal and wave action at

Matunuck Point and east of Sand Hill Cove. At the west end of the alignment, where the barrier ties into high ground, there exists man-made fill composed mainly of boulder type material.

Adjacent to the landside ponds, located between Stations 1+00 to 2+25 and 34+00 to 41+50, the deposit of surficial sands is approximately 5 feet thick and overlies a soft salt water march organic deposit in small thickness. Underlying the marsh deposits, the foundation materials, based on probes and geological history, are firm granular materials.

Except within the limits of the fresh water pond, Station 175+50 to 177+25, the foundation materials along the most easterly 1,000 feet of the alignment are overlain by an organic deposit, less than 2 feet in thickness. This area is partially overgrown with scrub brush. Within the limits of the pond, a deposit of soft organic soil, in the order of 4 feet in thickness, overlies firm foundation materials.

Explorations at the location of "The Breachway Control Structure" indicate that, in the area of the western portion of the structure, there exists, below the proposed footing elevation, deposits composed of organic silt and loose sands with organics with a total thickness of 15 feet. Underlying these deposits to a maximum explored depth of 80 feet are granular deposits consisting of moderately compact to compact variable mixed silty sandy gravels and gravelly silty sands.

b. Soil Characteristics. Laboratory tests to determine the various soil characteristics were not performed on samples of any of the foundation materials. Based on the size, shape and types of the proposed structures, the foundation sands and gravels are considered adequately safe against shear failure. Marsh deposits, except for that underlying the surficial capping of sand, will be removed prior to construction of the structure. Those buried are sufficiently deep and thin enough so as not to present a foundation stability problem for embankment structures. Due to the existance of deposits containing organic silt and sand with organics in the foundation area of the Breachway Control Structure, the structure will be founded on piling.

The sand and gravel foundation materials characteristically exhibit high permeabilities. Considering the type and size of the barrier structure and the magnitude of the maximum hydrostatic head possible, no permeability tests were made on foundation soil samples.

Foundation materials, except for marsh deposits, exhibit very low compressibility. Marsh deposits, while relatively compressible, will not be a factor in the design of beaches and dikes. The

surficial deposit will be removed prior to construction of the barrier while the buried deposits are thin enough so that settlement of dike and beaches, if any, will be minor and will occur during construction.

23. DESIGN OF EMBANKMENTS

a. General. For most of the alignment, the proposed barrier will consist of sand dunes formed by hydraulic fill and placement of select sand from a borrow area and rock dikes constructed essentially of rock materials of variable weights placed in layers of varying thickness. The design of the barrier for these reaches is covered in Paragraph 38 and typical sections are shown on Plate Nos. 2-12 through 2-14.

In other reaches of the alignment, the barrier will consist essentially of compacted earth fill dikes flanked with suitable rock and gravel materials. These earth fill dikes will be located between Stations 0+50 and 44+50 and 174+00 and 181+00. Typical sections of the earthfill dikes are shown on Plates 2-12, 2-13 and 2-14. The design of these dikes has been based on current design criteria as set forth in the pertinent sections of the Engineering Manual and the typical sections have been developed from investigations of foundation conditions, characteristics of available construction materials and the location and height of the structure. The earth fill material for these dikes will be obtained from surficial deposits after removal of materials containing organics, in the borrow area for selected beach sand. The earthfill material will be non-plastic, well-graded silty sand and sandy silt containing between 25 and 60 percent silt sizes. Except for that portion of the barrier between Station 175+50 to Station 177+25, where a small fresh water pond will be crossed, all earth fill material will be compacted. Where the dike crosses the small pond, earth fill material will be dumped to an elevation of plus 2 MSL and compacted above that elevation. The earth fill in the dikes will exhibit low permeability and will have sufficient strength to prevent shear failure of the dikes.

b. Seepage Control Through Earth Fill Dikes

(1) Embankment through seepage. Seepage through the embankment portion of the earth fill dikes is provided for with the incorporation of land side toe drains of gravel fill in the otherwise homogeneous section of compacted earth fill. The land side slopes of the dikes, for reasons stated in Paragraph 16, will have a 12-inch layer of protection rock overlying a layer of gravel bedding. As a result of the effectiveness of these slope layers to control any seepage emerging on the landside slopes, the landside toe drains were limited in size to those shown on the drawings.

(2) Foundation through seepage. Those portions of the earth fill dikes where the top of the dike is more than 8 feet above the landside toe, the dike will be provided with a landside foundation toe drain, 5 feet deep, to control the seepage through the foundation. Where the height is less than 8 feet, the base of the dike is considered sufficiently wide to prevent detrimental seepage at the landside toe.

c. Slope Protection for Earth Fill Dikes. The slopes and tops of the compacted earth fill dikes will be protected from wave action and erosion with rock armor and rock protection underlain by suitable zones of finer rock and gravel bedding. The design of the various layers of these materials is discussed in Paragraph 16. In addition, the rock protection and gravel bedding will serve to control embankment through seepage on the landside slopes.

M. NAVIGATION

24. DESCRIPTION OF NAVIGATION CONDITIONS

The growth of recreational boating, commercial fishing and commercial establishments in Point Judith Pond has outdistanced even the most optimistic estimates of a few years ago. Channel and anchorage improvements are needed to reduce tidal delays, channel traffic hazards and anchorage congestion for existing and future commercial and recreational craft.

Navigation improvements in the Point Judith area are concentrated in the Point Judith Harbor of Refuge and Point Judith Pond. The Harbor of Refuge is an artificial harbor formed by three Federal breakwaters that shelter an area of 770-acres, including 200 acres 24 to 30 feet deep. No terminal facilities of any kind are located in the Harbor of Refuge.

Point Judith Pond is a tidal lagoon connected to the Harbor of Refuge by a Federal channel 15 feet deep, which extends to terminal facilities just north of "The Breachway", through the barrier beach. The Pond, dotted with Islands and shoals, extends about 4 miles north to the Town of Wakefield, and is about one mile wide. Natural depths average about 3 feet and are generally less than 8 feet.

The mean tide range is 3.1 feet in the Harbor of Refuge, 3.0 feet in the Pond near "The Breachway", and 2.9 feet at Wakefield, at the head of the Pond. Maximum tidal currents are less than one knot in the entrances to the Harbor of Refuge between the breakwaters, but average 2.9 knots on the flood and 2.7 knots on the ebb through the Breachway entrance to Point Judith Pond.

25. EXISTING FEDERAL NAVIGATION PROJECT

The existing Federal navigation project for Point Judith Harbor and Pond was authorized by Congressional Acts in 1890, 1907, 1910, 1919, and 1948 and consists of the following:

a. Harbor of Refuge. The improvement for the Harbor of Refuge consists of a main breakwater, 6.970 feet long, roughly V-shaped, with its apex facing outward in about a south by west direction, and lying from 1/2 to 1-1/4 miles from shore; an easterly shore arm breakwater, 2,240 feet long, east of the main breakwater, leaving an entrance to the harbor 1,200 feet in width; a west shore arm breakwater, 3,640 feet long, extending toward the west arm of the main breakwater, leaving an entrance to the harbor 1,500 feet in width; and for the removal of two shoals, one in the anchorage area and the other near the easterly entrance, to a depth of 18 feet at mean low water. All breakwaters are of the rubble mound type, with the crests 8 and 10 feet above mean low water. The breakwaters were completed in 1914 and dredging of shoals in the project area was done in 1921. Major rehabilitation of the main and east breakwaters was commenced in December 1961 and restored to project design dimensions in 1963.

b. Point Judith Pond. The improvements for Point Judith Pond consist of a channel from the west entrance of the Harbor of Refuge, along the inside of the west shore arm, into Point Judith Pond, 15 feet deep and 150 feet wide, between the jetties at "The Breachway", and extending on the west side of the pond to a point 100 feet north of State Pier No. 4 at Jerusalem, with a branch channel, 15 feet deep and 200 feet wide, on the east side of the pond extending to a point 100 feet north of State Pier No. 3 at Galilee; an anchorage basin just inside the entrance, 10 feet deep with an area of about 5 acres; a sand arresting structure consisting of an impermeable core at the shore end of the west breakwater; a channel, 6 feet deep and 100 feet wide, from the 15-foot west branch to the head of Upper Pond at Wakefield, with an anchorage basin 6 feet deep and about 6 acres in area at the upper end. The existing project was completed in 1950 and the channels last maintained in 1959.

26. MULTIPLE-PURPOSE NAVIGATION IMPROVEMENTS

The multiple-purpose project, including hurricane protection, navigation improvements, and beach erosion control measures will provide extensive navigation improvements as the dredged material from all areas, except those at Snug Harbor and north of Snug Harbor, can be economically placed, by hydraulic dredge, on the contiguous beaches for hurricane and beach protection. The navigation features of the multiple-purpose project are as follows:

a. Entrance Channel. The existing channel to Point Judith Pond will be relocated in a straight line, approximately 4,400 feet long, from the west opening of the Harbor of Refuge, through the breakway, 150 feet wide and 20 feet deep mlw (21.45 feet msl). The west branch in the inner harbor will remain 15 feet deep mlw, (16.45 feet msl) and the east branch will be deepened to 20 feet mlw (21.45 feet msl).

b. Inner Harbor Anchorage. The existing 5-acre inner harbor anchorage will be enlarged an additional 11 acres, 10 feet deep mlw (11.45 feet msl), for a total of 16 acres.

c. Little Comfort Anchorage. A new 8-acre anchorage, 8 feet deep MLW (9.45 feet msl) will be dredged between Galilee and Little Comfort Island.

d. Channel to Little Comfort Anchorage. An access channel approximately 2,200 feet long will be dredged along the State finger piers and parallel to the anchorage. About 1,700 feet will be 150 feet wide and the remaining 500 feet will be 100 feet wide, all to a depth of 10 feet mlw (11.45 msl).

e. Snug Harbor Channel and Anchorage. A new 100-foot wide channel, approximately 2,200 feet long, will be dredged from the Wakefield channel to a 5-acre anchorage in the Potter Pond Channel, south of Snug Harbor, all to a depth of 8 feet mlw (9.5 feet msl).

f. Wakefield Channel and Anchorage. Deepen the existing 100-foot wide channel from State Pier No. 4 to Upper Pond in Wakefield, approximately 20,000 feet long, and the existing 6-acre anchorage in Upper Pond from 6 feet mlw (7.45 msl) to 8 feet mlw (9.45 msl).

g. Wakefield Anchorage. The existing anchorage will be enlarged by 7 acres, and dredged to a depth of 8 feet mlw (9.45 feet msl) for a total area of about 13 acres.

h. Breachway Control Structure. An ungated opening will be provided at "The Breachway" to reduce hurricane flood levels in Point Judith Pond. The existing opening will be narrowed to the existing channel width of 150 feet, with a channel depth of -23.0 feet mlw (-24.5 feet msl). Rock-faced dikes and concrete abutments, protected by wood pile fender will close off the overbank area on either side of the channel. The ungated opening will cause only a slight increase of 0.5 knot in the normal current, up to 3.4 knots, occurring in the immediate vicinity of the structure. There will be no noticeable reduction in tidal range.

27. BENEFITS DERIVED FROM IMPROVEMENTS

The benefits to be derived from the deepening of the entrance channel are commercial navigation benefits and the cost will therefore be borne entirely by the Federal Government. The benefits attributable to the remaining improvements are recreational in character.

It is considered that additional fishing boats will be attracted to Point Judith Pond if the entrance channel is deepened to 20 feet mlw. The U. S. Fish and Wildlife Service has estimated that one fishing boat would be newly purchased as a result of the improvement, and that 34 boats would be transferred from other harbors. In addition, benefits will accrue to the Block Island Ferry, by a savings in time in using a straight entrance channel.

The benefits accruing to the existing recreational fleet are considered to be the increased annual net return to the owners, through increased use. The annual net return to the owners has been taken as the amount the owners would receive if they chartered to others, and was computed at various percentages of the present depreciated boat value for various classes of boats, in accordance with available studies of boating practice. In view of the present congestion in the pond, it is considered that the owners now receive only 80 to 90 percent of the return possible under ideal conditions. It is estimated that construction of the plan of improvement will increase the return to 100 percent and attract an additional 74 new boats to the area.

28. DREDGING ESTIMATE

The estimated quantity of sand was based on dredging to the project depths plus an allowance of one foot for overdepth and side slopes of 1 vertical on 3 horizontal. A summary of the quantities and the location of the available material for hurricane and beach erosion control is shown in Table III.

TABLE III

DREDGING ESTIMATE

PUMP	Entrance Channel (part scow)	220,000 c.y.
	Inner Harbor Anchorage	56,500 c.y.
	Sub-Total	276,500 c.y.
SCOW	Little Comfort Channel & Anchorage	54,000 c.y.
	Snug Harbor Channel & Anchorage	140,000 c.y.
	Wakefield Channel & Anchorage	115,000 c.y.
	Sub-Total	309,000 c.y. *
	TOTAL	585,500
	Rounded To	585,000 c.y.

* This quantity considered as uneconomical for hurricane protection and beach erosion control use.

29. MAINTENANCE

Annual maintenance of the channels and anchorages has been estimated in accordance with past experiences of the area, and is shown in Table IV.

TABLE IV

ANNUAL MAINTENANCE

Entrance Channel	1,500 c.y.
Inner Harbor Anchorage	750 c.y.
Little Comfort Anchorage	1,000 c.y.
Channel to Little Comfort Anchorage	2,000 c.y.
Snug Harbor Channel & Anchorage	1,000 c.y.
Wakefield Channel & Anchorage	500 c.y.
Wakefield Anchorage (additional 7 acres)	400 c.y.
TOTAL	7,150 c.y.

30. CONSTRUCTION SCHEDULE

Dredging of the navigational items below Snug Harbor will be accomplished concurrently with the hurricane protection and beach erosion construction.

The navigational items north of Snug Harbor will be accomplished under separate contract, as the dredged material will be placed on spoil areas or barged out to sea. However, all items of the navigational feature of the multiple-purpose project will be completed prior to acceptance of the overall project.

N. BEACH EROSION

31. GENERAL

The beach erosion aspects of the area have been thoroughly covered in beach erosion control studies completed for the south shore of Rhode Island in 1949, and for South Kingstown and Westerly, Rhode Island, in 1958. As a result of the former study, the existing beach erosion control project for Sand Hill Cove was constructed. The latter study is the basis for an authorized project to provide for sand fill and a system of groins at East Matunuck State Beach. The hurricane survey report discussed the beach erosion problems for the shore front developing the beach protection in accordance with recommendations from those studies and to best correspond to the natural beaches found to be stable for the area.

32. SHORE FRONT PROBLEM

The shore front is subjected to erosion during serious storms with winds predominantly from the southwest to the southeast. Past

studies indicate that the mature nature of the shore front has stabilized the fore shore and near shore areas to such a degree that losses during these storms are far less serious than what occurs during hurricanes with higher flood levels exposing the more erodible back shore areas to erosive processes and serious losses.

The most seriously eroding area is Matunuck Point Headland and the East Matunuck State Beach area. The construction of the breakwaters to the east fronting "The Breachway" interrupts any flow of material from theeast during southeasterly storms, but offers some protection to the eastern portion of East Matunuck State Beach during these storms. There is an acretion of sand fill on the west side of the breakwaters from littoral movement of material from the west during southwest storms. The movement of materials along the shore from within the Point Judith Harbor of Refuge is associated with waves diffracted through the openings in the breakwaters complicated by reflections from the structures. The area to the east of Sand Hill Cove State Beach shows marked erosion with cobbles distributed along the shore front. The State Beach is quite stable with some steepening of the new shore areas and redistribution of beach fill toward the back shore during serious high level storms. The erosive state of the shore front to the east is largely attributed to an insufficient supply of beach building material for this area from sources outside of the breakwaters.

33. DESIGN CRITERIA

The beach protection is designed to give protection against ordinary storms of comparatively frequent occurrence and to provide a wider beach to resist hurricane-driven waves and in conjunction with backup dikes function to prevent overtopping during the design hurricane. Maintenance requirements for the beach are estimated as that required to renourish the beach during frequent serious storms increased by up to fifteen percent to allow for losses during less frequent hurricanes. Sand fences as presently used at Sand Hill Cove State Beach will be utilized along the backshore of East Matunuck State Beach during the off season to contain wind sand.

34. TIDES

As discussed in the Design Memorandum on Hydrology and Hydraulics, tides are semidurnal with a mean tide range of 3.1 feet and a maximum spring range of about 6 feet at Matunuck and Point Judith Harbor of Refuge. It is estimated that storms with a

frequency of once a year might have flood levels of 6 feet above mean sea level and 4 feet above mean sea level at Matunuck and Point Judith Harbor of Refuge, respectively. Once in ten years, flood levels of 8 and 6.5 feet above mean sea level might occur at these respective locations. Design hurricane stillwater levels are 12.5 and 10.5 feet above mean sea level at the respective locations.

35. BEACH EROSION PROTECTION

The beach erosion protection is considered as that improvement which fronts constructed backup dikes or restored dunes and is formed by either reshaping existing stable areas or by widening of the beach by direct placement of sand fill. The beach protection furnishes protection to the backup structures by causing waves to break offshore. They also limit wave run-up during major storms and hurricanes. The major beach erosion protection consists of beach widening along East Matunuck State Beach and widening of the shore front to the east of Sand Hill Cove State Beach. The following is a description of the pertinent details relating to the design and construction of the beach erosion improvements:

a. Beach Widening. The artificial placement of sand fill for widening the beach is accomplished to the required dimensions necessary to prevent overtopping of the back-up dikes during the design hurricane. This requires that the berm elevations be at the design stillwater elevation of 12.5 feet above mean sea level for East Matunuck State Beach and 10.5 feet above mean sea level for Sand Hill Cove State Beach. The berm widths are based on those found to afford protection within the area. Beach slopes utilized are 1 on 20 for East Matunuck State Beach and 1 on 15 for the more sheltered beach at Sand Hill Cove and areas to the eastern termination. For details of these beaches and other shore front areas, see Plates 2-12 and 2-13.

b. Sand Characteristics. Existing beach materials indicate sand fill with a median diameter of about .20 mm. Investigations for dredged materials within the nearby Point Judith Pond determined that much of the material was either entirely unsuitable as beach fill due to organic content or was silty to fine and inadequate for use in construction of the beach below elevations subject to the most serious storms. A land source sand fill with a median diameter of .40 mm will be utilized in construction of the beach toe below elevation 6 feet above mean sea level, which will be more resistant to erosion from serious frequent storms and will more nearly maintain the design slopes. The fine dredged material will be used to construct the remainder of the beach fill. The heavier land fill will be extended in a 2-foot cover layer to 8 feet above mean sea level and utilized for renourishing the beach.

c. Groins. It is planned to construct two groins at East Matunuck State Beach and repair the five existing groins at Sand Hill Cove State Beach. The groins at East Matunuck State Beach would be extended to and back of elevation 8 feet above mean sea level to the face of the 100-foot berm. This is well above the more frequent storms. The design hurricane stillwater level would be maintained for a very short period of time; therefore, flanking is considered to be very unlikely. The design of the groins is therefore based on providing erosion control for the most frequent serious storms. They will also be stable during the aforementioned infrequent and shorter duration design hurricane. The design of the structures is in accordance with the formula developed by the U. S. Army Waterways Experiment Station and described in EM 1110-2-2904, dated 30 April 1963, entitled: "Engineering Design of Breakwaters and Jetties".

d. Method of Beach Construction. The dredged materials will be pumped on the beach behind the final 6' mean sea level line. The land borrow material will be dumped to form a dike at this point and be graded seaward before dredged material is placed. A sufficient quantity of land borrow will be pushed into the sea for the toe to be shaped by natural processes. For stability, a 2-foot cover layer will be provided up to 8-foot mean sea level to add stability to the beach during storms of approximately 1 in 10 years frequency. The two groins at East Matunuck State Beach should be constructed as first priority and the groins at Sand Hill Cove firmed up before sand fill operations proceed. At Sand Hill Cove within the area where an adequate beach section presently exists, the coarser materials will be added during annual maintenance requirements.

e. Maintenance. It is estimated that the greatest losses will occur during frequent serious storms with predominant winds from the southwest through the southeast. These storms would expose the toe to erosion processes up to elevation 6 feet above mean sea level. The greatest losses would occur at East Matunuck State Beach. Here, it is estimated that without the use of groins, about twenty-five percent of the volume would be lost annually, but by providing the groin, this loss would be reduced by twenty five percent. Somewhat less losses are assumed for the remainder of the shorefront. The losses have been increased by a factor ranging from 10 to 15 percent to allow for losses experienced during infrequent hurricanes. It is estimated that 40,000 cubic yards of beach nourishment will be required annually.

36. ANNUAL COSTS

The annual cost of beach replenishment and maintenance of the groin structures by local interests is estimated at $80,000 and

$1,000, respectively to be included in the economics of the Overall Water Resources Development Plan.

37. BENEFITS

The estimated benefits include direct damage prevented and recreational benefits. The only recreational beach benefits utilized will be for East Matunuck State Beach. It is considered that development of appurtenant facilities must be accomplished in order that the estimated recreational benefits will result. Peak day beach attendance of 18,000 has been estimated for East Matunuck State Beach. Total attendance is computed from attendance distribution curves developed from daily attendance records at Rocky Neck State Beach in Lyme, Connecticut. This resulted in an annual attendance of 286,300 determined in the year 1958 Beach Erosion Study. It is believed that increased recreational activities will increase this to 347,000. The value of recreational benefits at $.75 per person is estimated at $260,000 and damages prevented at $5,000. These benefits are incorporated in the Overall Water Resources Development Plan.

O. DESCRIPTION OF PROPOSED STRUCTURES AND IMPROVEMENTS

38. GENERAL

The project is a multiple-purpose one, consisting of Hurricane Flood Protection, Beach Erosion Control, and Navigation Improvements. The plan provides for the restoration of the sand dunes, beach raising and widening, an ungated concrete breachway control structure and navigation improvements. It is separable into four distinct parts: west of "The Breachway", "The Breachway", east of "The Breachway" and the Navigation Improvements. It commences at high ground at Matunuck State Beach just west of Matunuck Beach Road and extends easterly, approximately three and one-half miles, crossing the existing navigation channel to Point Judith Pond at "The Breachway", to high ground at Sand Hill Cove. The features of the project are presented in the following paragraphs.

a. West of "The Breachway". This segment commences at high ground just west of Matunuck Beach Road. It is a continuous structure and from west to east consists of the following:

(1) Earth and Rock Dike. An earth dike with rock slope protection, approximately 400 feet long, will be constructed. Top elevation is 16.0 feet above mean sea level. It will have a top width of 10 feet, and slopes of 1 on 3 and 1 on 2.5 on the ocean and land sides, respectively.

(2) Earth and Rock Dike. An earth and rock fill dike with rock slope protection, approximately 2,800 feet long, will be constructed. It will have a top elevation of 20.0 feet above mean sea level, a top width of 10 feet, and side slopes of 1 on 3 and 1 on 2.5 on the ocean and land sides, respectively.

(3) Earth and Rock Dike. An earth and rock dike with rock slope protection, approximately 1,100 feet long, will be constructed. It will have a top elevation of 20.0 feet above mean sea level, a top width of 20.0 feet, and side slopes of 1 on 3.

(4) Rock Revetment. A sand and rock revetment, approximately 650 feet long, will be constructed. It will have a top elevation of 20.0 feet above mean sea level, a top width of 10 feet, and side slopes of 1 on 6 and 1 on 3 on the ocean and land sides, respectively.

(5) Dune and Beach. A sand fill dune, approximately 4,350 feet long, will be constructed. It will have a top elevation of 17.5 feet above mean sea level, a top width of 25 feet and side slopes of 1 on 5. The beach fill will commence at elevation 12.5 feet above mean sea level, on the ocean side slope of the dune, remain level for 100 feet, then slope 1 on 20 to existing ground surface.

Within this reach, two rock groins, approximately 400 feet long, will be constructed.

(6) Groins. Groin No. 1, approximately 400 feet long, will be located at Station 72+50. It will start at the end of the ocean side berm which is at elevation 12.5 feet above mean sea level. It will vary in elevation from elevation 8.0 to elevation 2.55 feet above mean sea level. The first 240 feet will be 6.0 wide at top, with side slopes of 1 on 2.5 and be constructed on 1.0 foot blanket of rock bedding, with a core of well-graded rock fill to a maximum rock size of 600 pounds and with a 2-foot thick rock armor covering of 1 to 3 ton maximum rock. The next 125-foot section will be the transition. The top width will vary uniformly from 6.0 to 12.0 feet. It will be founded on a 1.0-foot thickness of rock and rock bedding and will have a core of well-graded rock fill to 1/2-ton maximum and the rock armor will transition uniformly from 2 to 4.0 feet in thickness and from 1 to 3 ton maximum to 5 ton maximum rock size. The remaining segment will be 12 feet wide at the top with rock side slopes of 1 on 2.5. It will be founded on the 1.0-foot blanket of rock bedding, with a core of well-graded rock fill to 1/2 ton maximum size, with a 4-foot thickness of rock armor to a 5-6 ton maximum rock size. The foundation of rock bedding will be required to extend 3.0 feet minimum beyond the limits of the outside rock armor slope.

Groin No. 2, approximately 400 feet long, will be located at Station 97+00. It will start at the end of the ocean side berm which is at elevation 12.5 feet above mean sea level. It will vary in elevation from 8.0 to 2.55 feet above mean sea level. The first 225 feet will be 6.0 feet wide at top, with side slopes of 1 on 2.5 and will be founded on a 1.0 blanket of rock bedding, with a well-graded rock fill core to a maximum rock size of 600 pounds, protected by a 2-foot thick layer of rock armor stone of 1 to 3 ton maximum rock. The next 125-foot segment will transition uniformly from a 6.0 to 12.0-foot top width with 1 on 2.5 side slopes. It will be founded on a 1.0 thick blanket of rock bedding, with a core of well-graded rock fill to 600 pound maximum size stone protected by a uniformly varying layer of armor stone ranging in thickness from 2 to 4 feet and in maximum rock size from 5 to 6 tons. The remaining segment will be 12 feet wide at the top with 1 on 2.5 side slopes. It will be founded on a 1.0 foot blanket of rock bedding with a core consisting of a well-graded rock fill to a 1/2 ton maximum rock size, protected by a 4.0-foot thickness of rock armor with a rock size from 5 to 6 tons.

The rock foundation will extend 3.0 feet beyond the limit of the outside neat lines of the rock armor protection on all sides.

b. "The Breachway". "The Breachway" will be the center of the protection. It will be approximately 2,000 feet long including the 150-foot ungated navigation opening, and from west to east will consist of the following structures:

(1) Rock Dike. A rock dike, approximately 900 feet long starting from the east side of the western end of the sand dune and extending to the concrete abutment, will be constructed. It will consist of a gravel core with protective layers of gravel bedding, rock bedding, and rock armor. The top widths will be 10 and 15 feet and will be at elevation 16.0 feet above mean sea level. The side slopes will be 1 on 2. The ocean side and top protective layers will consist of 4.0 foot of 1 to 2 ton rock, on 2.0 foot of 50-500 pound rock bedding, on 1.0 foot of gravel bedding. The land side protective layers will be of the same weight and thicknesses except the rock armor which will be only 2.0 foot thick. There will be a 12.0-foot berm of the rock protection layers on the ocean side toe and an 8.0-foot berm of the rock protection layers on the land side.

The transition section will occur in the 50-foot section before the concrete abutments. The gravel fill core and bedding will be replaced by rock fill and the rock protective layers will

increase uniformly to 3.0 foot thickness of 600 pound maximum rock bedding and to 8.0 foot thickness of 4 to 6 ton rock armor on both sides. This protection will then be wrapped around the concrete abutment.

(2) Breachway Control Structure. An ungated concrete structure will be constructed across the existing navigation channel in the Breachway. It will be founded on piles and be approximately 350 feet long including the 150-foot ungated opening. It will be constructed of mass concrete and, in general, will be at elevation 16.0 feet above mean sea level. Navigation aids will be located on it on each side of the navigation channel. Sections on each side will be at elevation 12.0 feet above mean sea level with a 6.0-foot portion, adjacent to the navigation channel, on each abutment at elevation 6.0 feet above sea level. On each side of each abutment, from this 6.0 feet above sea level platform, a timber walkway, approximately 200 feet long over-all will be constructed. More complete details will be included in Design Memorandum No. 6 - "Breaching Structures and Walls".

(3) Rock Dike. Another rock dike similar in all details as in a. above will be constructed from the east abutment of the gate structure east for approximately 750 feet. It will transition to an earth fill with rock armor protection in 100 feet.

(4) Rock Sill. Across the navigation channel between the abutment of the concrete control structure a rock sill will be constructed. The top elevation of the sill will be minus 24.45 feet below mean sea level (minus 23.0 below mean low water) and its side slopes will be 1 on 4. It will be 60.0 feet wide at top and will consist of a 3.0-foot layer of 500 pound maximum size rock armor on a 2.0-foot layer of quarry chips or equivalent fill. The minimum section will be 5 feet high.

c. East of "The Breachway"

The eastern section of the protection will be approximately 5,900 feet long and from west to east is continuous consisting of the following structures:

(1) Bulkhead. The bulkhead, approximately 1,965 feet long, will be constructed. It will start at Station 122+00 from the sand dune. It will consist of a continuous prestressed concrete pile core wall with sand fill. The top elevation of the wall will be 22.0 feet above mean sea level. Ocean side of the core wall there will be a 5.0-foot berm at elevation 18.5 feet above mean sea level. The side slopes will be 1 on 3 to existing ground surface.

(2) Dune and Beach Fill. After a transition section of 50 feet, the dune and beach fill, approximately 1,800 feet long will be constructed. The top elevation of the dune will be 17.0 feet above mean sea level and it will be 15.0 feet wide. The side slopes will be 1 on 5 and the ocean side slope will end at elevation 10.5 feet above mean sea level where a 50-foot berm will be constructed, from which the new beach fill will slope on a 1 on 15 to meet existing ground surface.

(3) Rock Dike and Beach Fill. A sand fill dike with rock armor protection along with beach fill, approximately 1,400 feet long, will be constructed. The top elevation will be 14.0 feet above mean sea level and its top width will be 10.0 feet. The ocean side slopes of the dike will be 1 on 3 and the land side slope will be 1 on 2.5. The ocean side protection will consist of a 2.5-foot layer of 500 pound maximum size rock armor on a 1.0-foot layer of 50 pound maximum size rock bedding on 1.0-foot layer of gravel bedding. The land side protection will consist of a 1.0 layer of 500 pound maximum size rock protection on a 1.0-foot layer of gravel bedding. The top of the structure will consist of 1.5-foot layer of 500 pound maximum size rock armor on a 1.0-foot layer of 50 pound maximum size rock bedding on a 1.0-foot layer of gravel bedding. The ocean side toe will be protected by an 8.0-foot wide rock berm consisting of the same layered protection as on the ocean side slope. The beach fill will start at elevation 10.5 feet above mean sea level on the ocean side slope and extend level for 50 feet. It will then slope on a 1 on 15 to meet existing ground.

(4) Earth Dike. An earth dike, approximately 700 feet long, will be constructed to complete the protection in the Sand Hill Cove area. The top elevation will be 14.0 feet above mean sea level and it will be 10 feet wide. The side slopes will be 1 on 3 on the ocean side and 1 on 2.5 on the land side. The ocean side protection will consist of a 2.0-foot layer of 500 pound maximum size rock armor on a 1.0-foot layer of 50 pound maximum size rock bedding on a 1.0-foot layer of gravel bedding. The land side protection will consist of a 2.0-foot layer of 500 pound maximum size rock protection on a 1.0-foot layer of gravel bedding. The top protection will be the same as that on the ocean side except that the thickness of the rock armor will be 1.0 feet. A section of this dike crosses a fresh water pond. It is proposed to excavate the pond to firm material and fill with dumped earth fill to approximately 2.0 feet above mean sea level on which will be founded the above described structure. The ocean side toe will consist of an 8.0-foot and 10.0-foot wide rock berm similar to the layered rock protection on the ocean side.

d. Navigation Improvements.

The navigation improvements are described in Paragraphs 24 to 30 of this report.

39. NAVIGATION AIDS

Navigation aids, as required by the U. S. Coast Guard, will be provided. Their comments are included as part of this design memorandum in Appendix B.

40. ACCESS

Access to the top and over the structures will be provided by stairways at locations along the structures to accommodate the private owners, as well as the public visitor. Ramps over the dike will also be provided.

41. OPERATING FACILITIES

No operating facilities are considered necessary at this installation. Since it will be the responsibility of local interests to operate and maintain it and there exist public owned facilities on each side of "The Breachway" from which to operate.

42. HOUSING FACILITIES

No housing facilities are considered necessary at this installation.

43. UTILITIES

All utilities, as required, will be provided by local interests.

P. VIEWS OF CONSULTANTS

44. CONSULTANTS

The advice of consultants in the Office, Chief of Engineers, was obtained in the development of design. The design still water level was selected as the still water level of record (21 September 1938). The design wave heights were established on the basis of studies made by the Department of Civil Engineering of the Massachusetts Institute of Technology to investigate certain aspects of the design of a hurricane barrier for the east passage of Narragansett Bay, Rhode Island. The report is the Hydrodynamics Laboratory Report No. 66, February 1964, titled "Study of Hurricane Barrier for Lower Narragansett Bay".

Q. ACCESS ROADS AND RAILROAD FACILITIES

45. ACCESS ROADS AND RAILROAD UTILITIES

a. Highways. Both U. S. Routes 1 and 1A with paved town roads service the area.

b. Railroads. The main line of the New York, New Haven and Hartford Railroad Company, the Boston to New York line, services the area. The nearest stop is Kingstown, Rhode Island, approximately 10 miles northwest of the project site, at which there are freight facilities available. The Narragansett Pier Railroad Company, Inc., connects with the New York, New Haven and Hartford Railroad Company at Kingstown and runs to Wakefield, Rhode Island, which is approximately 5 miles north of the project site.

R. SOURCES OF CONSTRUCTION MATERIAL

46. SOURCES OF CONSTRUCTION MATERIAL

Sources of construction material are covered in paragraph 19 of this report.

S. REAL ESTATE REQUIREMENTS

47. GENERAL

The acquisition of land will be in accordance with the criteria contained in letter from the Chief of Engineers, ENGRE-A, ENGCW-O, Hurricane Flood Protection Projects (NED), dated 18 July 1960, Subject: "Clarification of Local Cooperation Requirements for Hurricane Flood Protection Projects". Description of the area and details pertaining to the acquisition of the real estate will be included in Design Memorandum No. 5, "Real Estate".

REAL ESTATE COSTS

LANDS

0.5 acres commercial	@ $85,000 per acre (beach front)	$ 42,500
20.0 acres residential	@ $17,500 per acre (beach front)	350,000
10.0 acres residential	@ $ 8,500 per acre (less beach front)	85,000
9.0 acres marshland	@ $ 100 per acre	900
94.0 acres borrow area	@ $ 350 per acre	32,900
30.0 acres temporary work easement (est. rental value P/A)		600
		$511,900

IMPROVEMENTS

3 residences	$ 25,000
23 summer cottages	110,000
1 road side stand	500
1 bath house	5,000
	$140,500

SEVERANCE DAMAGES

Consisting of

1. Loss in Value to the remaining parts of ownership due to the reduction of its highest and best use.

2. Loss in Value due to proximity of the barrier to the structure.

3. Loss in Value due to the reduction of vehicular parking areas to commercial enterprises.

4. Loss in Value due to more difficult access to remaining areas.

The estimated costs for damages of this character are... $188,800

ADMINISTRATIVE COSTS

(1)	Mapping, Survey & Legal Descriptions	152 @ $350	$ 53,200
(2)	Appraisal and Review		25,000
(3)	Negotiations & Closings	152 @ $ 50	7,600
(4)	Condemnations (est. 20 ownerships)		5,000
(5)	NED Advisory Expense		6,000
			$ 96,800

SUMMARY OF REAL ESTATE COSTS

LANDS	$511,900
IMPROVEMENTS	140,500
SEVERANCE DAMAGES	188,800
ADMINISTRATIVE COSTS	96,800
	$938,000
Contingencies, 5%	46,900
TOTAL ESTIMATED REAL ESTATE ACQUISITION COSTS.....	$984,900
ROUNDED TO.....	$985,000

T. RELOCATIONS

48. UTILITIES

a. Water. The only modifications required to the existing water lines will be the plugging of water service lines, to cottages,

in the Stanton Avenue and Succotash Road areas and the possible relocation of individual wells in the Matunuck Beach Road Area. The existing 8-inch water line, which lies in Point Judith Pond from Little Comfort Island to Jerusalem may require lowering when the navigation channel is deepened. This 8-inch water line lies within the work area under a Federal permit any required relocation will be accomplished at no cost to the Government.

b. Sewer. There is no municipal sewer in the area. Some of the existing individual sewage disposal system may require relocation due to the construction of the project.

c. Drainage. There is one small collector system in the area. It consists of two drop inlets with a connecting pipe and an outflow pipe to the ocean. It is proposed to discontinue a portion of the existing system that which is on the area of the protection. The remainder will be diverted into a new system which will flow to a tidal pond behind the protection. Behind the proposed bulkhead, it is proposed to grade the area to divert the water away from the homes and the bulkhead, see Plate 2-11.

d. Electric and Telephone. There are some structures remaining on the ocean side of the project. Some of the drops for both power and telephone may require relocation and/or rearrangement to allow for passage of maintenance equipment, as well as minimum clearance.

RELOCATIONS ESTIMATE

Item	Unit	Unit Price	Amount
Water and Sewer			
Relocate Water Supply Wells	5 ea	$200.00	$ 1,000
Plug Existing Water Service Lines	10 ea	15.00	150
Relocate Sewage Disposal Systems	5 ea	400.00	2,000
			$ 3,150
Drainage			
Drainage System			11,000
TOTAL WATER AND SEWER			$14,150

Item	Unit	Unit Price	Amount
Electric & Telephone			
Remove Poles 35 feet long	8 ea	$ 50.00	$ 400
Install Poles 45 feet long	6 ea	210.00	1,260
Install Poles 40 feet long	2 ea	190.00	380
Depreciation Allowance	L.S.		-140
TOTAL ELECTRIC AND TELEPHONE			$1,900

U. COST ESTIMATE

49. COST ESTIMATES

The total estimated cost of the project is $7,100,000, which is more than the latest approved estimate of $4,640,000. The difference is due to more detailed design studies. A summary of the costs of the various features of the work described in this design memorandum is given in Table V. A breakdown estimate is given in Table VI, starting on Page 41.

TABLE V

SUMMARY

Project Feature	Cost
Lands and Damages	$ 985,000
Channels and Canals Dredging, Hydraulic	342,000
Scow	562,000
Levees and Floodwalls	4,336,000
Engineering and Design	447,000
Supervision and Administration	428,000
TOTAL ESTIMATED PROJECT COST	$7,100,000

TABLE VI

DETAILED COST ESTIMATE
(June 1966 Base)

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
1	Prep. of Site			L.S.	$ 20,000
2	Stripping	16,000	C.Y.	$0.75	12,000
3	Excav., Unclass.	63,000	" "	0.75	47,250
4	Excav., Structures	27,000	" "	0.75	20,250
5	Comp. Earth Fill	38,000	" "	0.60	22,800
6	Sand Fill	743,000	" "	0.12	89,160
7	Sand Borrow	505,000	" "	2.00	1,010,000
8	Gravel Fill	5,000	" "	1.50	7,500
9	Gravel Bedding	44,300	" "	1.50	66,450
10	Comp. Gravel Fill	3,500	" "	1.70	5,950
11	Rock Armor (1-2 tons)	49,000	Tons	6.80	333,200
12	Rock Armor (2-3 tons)	36,000	"	7.10	255,600
13	Rock Armor (1-5 tons)	925	"	7.95	7,355
14	Rock Armor (3-6 tons)	2,700	"	7.80	21,060
15	Rock Armor (4-6 tons)	4,200	"	8.00	33,600
16	Rock Bedding	61,200	"	6.70	410,040
17	Rock Prot. (50-500#)	40,000	"	7.50	300,000
18	Groins				
	200# Chinking	400	"	7.125	2,850
	600# Chinking	400	"	7.125	2,850
	1,000# Chinking	1,350	"	7.50	10,125
19	Drainage Modification		L.S.	Job	11,000
20	Sand Fence	7,700	L.F.	1.00	7,700
21	Cofferdam		L.S.	Job	125,000
22	Fender System		L.S.	Job	45,000
23	Precast Conc. Pile Wall, 24 feet	1,950	L.S.	144.00	280,800
24	Precast Conc. Pile Wall, 13 feet	600	L.S.	78.00	46,800
25	Dredging, Hydraulic	276,000	C.Y.	1.15	317,400
26	Mob. & Demob. Hyd Dredge		L.S.	Job	25,000
27	Dredging, Scow	370,000	C.Y.	1.45	536,500
28	Mob. & Demob. Scow Dredge		L.S.	Job	25,000
29	Reshape Groins	1	L.S.	Job	20,000
30-	Wood Bearing Piles, 50'	560	each	120.00	67,200
31	Seeding, Beach Grass	80,000	S.Y.	0.50	40,000
32	Navigation Aids	1	L.S.	Job	13,000
33	Utility Modifications		L.S.	Job	5,050
34	Concrete Tremie	5,300	C.Y.	32.50	172,250
35	Concrete Mass	3,100	C.Y.	40.00	124,000

(Cont'd)

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Amount
36	Concrete Misc.	100	C.Y.	$90.00	$ 9,000
37	Stairs, Wood		L.S.	Job	7,000
					$4,555,740
	Contingencies, 15%+				684,260
					$5,240,000
	Engineering & Design, 8.5%+				447,000
					$5,687,000
	Supervision & Administration, 7.5%+				428,000
					$6,115,000
	Lands and Damages				985,000
	TOTAL ESTIMATED PROJECT COST				$7,100,000

V. SCHEDULE FOR DESIGN AND CONSTRUCTION

50. DESIGN

Design of the structures and preparation of contract plans and specifications are scheduled for completion in November 1966. Design of utility modifications and for relocations will be accomplished by the owner where feasible.

51. CONSTRUCTION

It is estimated that two (2) construction seasons will be required for construction of the project.

Contingent upon the availability of the necessary funds, construction of the project will be accomplished under two contracts. One contract will be for dredging the navigation channel from Snug Harbor to Wakefield, and the Anchorage area at Wakefield, which is considered uneconomical for the project. The second contract will include all the remaining features of the project. In order to preserve the recreational aspects of the area, it is proposed to limit the dredging of the channels to any time except between 30 May and Labor Day during the construction seasons.

Utility relocations will be accomplished by the owner.

W. OPERATION AND MAINTENANCE

52. OPERATION AND MAINTENANCE

Upon completion of the project, non-Federal interests will be responsible for the operation and maintenance of the hurricane tidal flood protection, beach erosion control improvements, and the breachway control structure.

The project will be operated and maintained in accordance with the project Operation and Maintenance Manual. The structures will be set up to operate the project in accordance with Public Law 87-874, 1962. Estimates of moneys required for maintenance and operation are contained in Appendix A.

Federal interests will be responsible for the maintenance of the navigation channels, anchorage area, and aids to navigation.

53. ANNUAL CHARGES

Annual charges amounting to $211,800 for Federal and $182,700 for non-Federal have been computed in accordance with EM 1120-2-104 using an economic project life of 50 years. These computations are set forth in Appendix A.

X. ECONOMICS

54. GENERAL

The Point Judith area has experienced heavy tidal flood losses in recent hurricanes due to its exposed location on the Atlantic Ocean. The Point Judith area is one of the most popular recreation resorts in the East. Swimming, recreational boating and sport fishing draw devotees to the area from a radius of over 150 miles. In addition to a large summer colony of Cottagers, there is an increasing number of year-round dwellers in the area. Both types of residential properties are centered around Point Judith Pond and Matunuck. These properties are subject to hurricane tidal flooding. There are also 30 commercial properties, including boat yards, marinas, fish processing facilities, and 900 acres of land in the flood plain.

55. TANGIBLE FLOOD DAMAGE PREVENTION BENEFITS

Tangible flood damage prevention benefits for the plan of protection were derived as the difference in annual losses to be expected in the project area over the life of the project without protection and those that would remain after construction of the protective works. Annual benefits so derived amount to $212,800.

In addition to the prevention of flood damages, the project would eliminate the costs of taking emergency preventive measures in the event of hurricane warnings. In the protected area, such costs amount to $4,200.00.

The project will also make available for higher usage some 18 acres of land now unused or under-utilized. Annual higher utilization benefits amount to $23,700.

The benefits derived from beach improvements are recreational, $260,000, and for prevention of damages, $5,000, a total of $265,000.

Annual prevention of boat damages is estimated to be $60,000.

The annual increase in navigation because of the project is estimated to be for commercial, $30,600, and recreational, $58,400, a total of $89,000.

The barrier will prevent the erosion of land fronting on the ocean and this is estimated at $7,300.

The total annual benefits amount to $662,000.

56. BENEFIT-COST RATIO

Annual costs for the project are $394,500. Annual benefits are $662,000. The benefit-cost ratio is $662,000/$394,900, or 1.7 to 1.

Y. COORDINATION WITH OTHER AGENCIES

57. COORDINATION WITH OTHER AGENCIES

All agencies indicated in paragraph 6 above were contacted and asked for their views on the project. The letters containing their comments on the project are reproduced in Appendix B.

Z. RECOMMENDATION

58. RECOMMENDATION

It is recommended that the project plan submitted in this report be approved as the basis for the preparation of plans and specifications for the Point Judith Water Resources Development Project.

APPENDIX A

COMPUTATIONS

APPENDIX A

COST SHARING COMPUTATION

TOTAL ESTIMATED PROJECT COST	$7,100,000.00
Federal Share, 69%	4,900,000.00
Non-Federal Share, 31%	2,201,000.00
CASH CONTRIBUTION	
Non-Federal Share	$2,201,000.00
Value, Lands & Damages	985,000.00
CASH CONTRIBUTION ...	$1,215,000.00

TABLE A-I

ESTIMATED ANNUAL COSTS
(1966 Price Level)

Federal Investment Costs		
Total Federal First Cost	$4,900,000.00	
Interest During Constr. 3.125%	153,100.00	
Total Federal Investment Costs		$ 5,053,100.00
Federal Annual Costs		
Interest on Investment, 3.125%		157,900.00
Amortization, 0.854%		43,200.00
Maintenance and Operation		
Dredging		
Entrance Channel	2,175.00	
Inner Harbor Anchorage	1,087.50	
Little Comfort Channel and Anchorage	4,350.00	
Snug Harbor Channel & Anchorage	1,450.00	
Wakefield Channel & Anchorage	725.00	
Add'l. Wakefield Anchorage	580.00	
	$10,367.50	
Navigation Aids	300.00	
Total Maintenance and Operation		10,667.50
TOTAL FEDERAL ANNUAL COSTS, ROUNDED		~~182,700.00~~
Non-Federal Investment Costs		
Contributed Funds	$1,215,000.00	
Lands and Damages	985,000.00	
Total Non-Federal First Costs	$2,200,000.00	
Interest During Constr. 3.125%	68,800.00	
Total Non-Federal Investment Costs		2,268,800.00

TABLE A-I (Cont'd)

Non-Federal Annual Costs

Interest on Investment, 3.125%		$ 70,900.00
Amortization, 0.854%		19,400.00
Maintenance and Operation		92,300
Sand Replacement (beach)	$80,000	183,100
Rock Cover Replacement	1,500	
Embankment and General	5,100	
Concrete Features	3,200	
Fender Guide System	1,200	
Drainage	100	
Groin Repair	1,000	
Sand Fence Repair	100	
Total Maintenance & Oper.	$92,200	
Allowance for Major Replacements		
Fender Guide System	600	
Total Non-Federal Annual Costs		183,100.00
TOTAL FEDERAL ANNUAL COSTS		211,800.00
TOTAL FEDERAL AND NON-FEDERAL ANNUAL COSTS		$394,900.00

COMPUTATIONS

ANNUAL COSTS - OPERATION AND MAINTENANCE

Concrete Value

Tremie	$172,250	
Mass	124,000	
Misc.	9,000	
Conc. Piles, 24'	280,800	
Conc. Piles, 13'	46,800	
		$632,850

Assumed 0.5% per year (632,850x.005 = $3,164)

SAY $ 3,200

Rock - Tons

Armor	92,825 tons	
Protection	40,000 tons	
Bedding	61,200 tons	
TOTAL		194,025 tons

Assumed one design storm in 50-year life of project with 5% loss of rock (194,000 x .05 = 9,700 tons)

Annual Loss = 9,700/50 = 194 tons

194 x $7.70/ton = $1,494 $ 1,500

Fender System

Assume complete replacement at end of 25 years and annual maintenance of 4/3%.

Present value, Fender System = $45,000
Present worth factor, 25 yrs hence @ 3.125% = 0.46334
45,000 x 0.46334 = Annual $ 20,850

Uniform annuity factor (.05823)
20,850 (.05823 $ 1,200
Annual maintenance = 45,000 x 4/3 x 1/100 = $ 600

Embankment and General

Put up and take down 7,700 L.F. of sand fence - once yearly @ .15/ft put up & take down .15 ft.

Reshape and handle 15,000 c.y. sand yearly 2 cy/ft 15,000 @ $.12 c.y.

Replace beach grass and fert.		$1,000
7,700 x .30 =		2,310
15,000 x .12-1/2		1,800
		$5,110
	USE	$5,100
Groin Repair		$1,000
Drainage System		$ 100
Sand Fence Repair		$ 100

SUMMARY

NON-FEDERAL ANNUAL COSTS - OPERATION AND MAINTENANCE

Item	Cost
Sand Replenishment	$80,000.00
Concrete	3,200.00
Rock	1,500.00
Fender System	600.00
Drainage System	100.00
Groins	1,000.00
Sand Fence	100.00
Embankment and General	5,100.00
Fender System (replacement 25 yrs)	1,200.00
TOTAL.....	$92,800.00 annually

APPENDIX B

LETTERS OF COMMENT

REGION ONE
CONNECTICUT
MAINE
MASSACHUSETTS
NEW HAMPSHIRE
NEW JERSEY
NEW YORK
RHODE ISLAND
VERMONT
PUERTO RICO

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

Gardner Building
40 Fountain Street
Providence, Rhode Island
02903

February 1, 1966

Mr. John Wm. Leslie
Chief, Engineering Division
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

Reference File No. NEDED-D
Point Judith, R.I., Water Resources Development Project
Your letter dated January 26, 1966

The Galilee Escape Road, Galilee Road, the road leading to Little Comfort Island and Great Island, all in the Town of Narragansett, and Matunuck Beach Road and Succotash Road in the Town of South Kingstown are all on the Federal-aid Secondary Highway System. Old Point Judith Road and Ocean Road in Narragansett and U.S. 1 in South Kingstown are on the Federal-aid Primary Highway System. To the best of our knowledge at this time, there are no Federal-aid highway projects proposed for any of these roads.

The initiative to propose projects on the Federal-aid highway systems rests with the various States' highway departments. If you have not already done so, may we suggest that you also contact the Rhode Island Department of Public Works for more detailed information on their plans for this area.

Sincerely yours,

R W Bergeron

R. W. Bergeron
For the Division Engineer

cc:
Regional Office
Delmar, N.Y.

EXHIBIT NO. 1

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
Region I
120 Boylston Street
Boston, Massachusetts 02116

February 9, 1966

Mr. John Wm. Leslie
Chief, Engineering Division
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

This is in response to your letter of January 20, 1966, requesting comments on the Point Judith, Rhode Island, Water Resources Development Project.

This office feels that that part of the project consisting of hurricane flood protection, beach erosion control, and navigation improvements will have little effect on any pollution problems that may exist in Point Judith Pond.

However, increased boating activities engendered by the proposed small boat anchorages at Inner Harbor, Little Comfort Harbor, Wakefield, and Snug Harbor would probably increase the amount of pollution entering Point Judith Pond and may necessitate the closing of this Pond to the taking of shellfish.

The Water Quality Act of 1965 directs the Secretary of Health, Education, and Welfare to call an enforcement conference whenever he finds that substantial economic injury results from the inability to market shellfish or shellfish products in interstate commerce because of pollution of interstate or navigable waters and action of Federal, State, or local authorities.

Accordingly, this office intends to study the problem of boat pollution in more detail and will submit the results and recommendations of this study at the earliest possible time.

Sincerely yours,

Alfred E. Peloquin
Chief, Water Quality Studies

EXHIBIT NO. 2

TREASURY DEPARTMENT
UNITED STATES COAST GUARD

Address reply to:
COMMANDER (o-1)
1ST COAST GUARD DISTRICT
1400 CUSTOMHOUSE
BOSTON, MASS. 02109

11400
29 MAR 1966

From: Commander, First Coast Guard District
To: U. S. Army Engineer Division, New England, Corps of Engineers, 424 Trapelo Road, Waltham, Massachusetts

Subj: Point Judith Water Resources Development Project, Narragansett and South Kingstown, Rhode Island

Ref: (a) C/E ltr NEDED-D dtd 7 Feb 1966

1. Subject project has been reviewed. Coast Guard operations will not be affected directly by the project. It has been determined that the following navigational aids will be required:

Breachway	-	One daybeacon on each side.
Navigation Improvement	-	Six new buoys and relocation of twenty-three existing buoys.

The estimated initial cost is $13,000 with an annual maintenance cost of $300.

2. It is requested that on future projects three copies of the plan be provided to permit submission of one copy to the Commandant, U. S. Coast Guard.

C. G. HOUTSMA
By direction

Encl: (1) C/E Drawing Nr. PJ-1-1000

Copy to:
Comdt (OAN) (w/o enclosure)

EXHIBIT NO. 3

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

DEPARTMENT OF HEALTH

STATE OFFICE BUILDING, PROVIDENCE 2

DIRECTOR OF HEALTH
JOSEPH E. CANNON, M.D., M.P.H.

February 1, 1966

Mr. John Wm. Leslie
Chief, Engineering Division
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

The proposed plan for the Point Judith, Rhode Island, Water Resources Development Project, has been reviewed.

The project consists of hurricane flood protection, beach erosion control, and navigation improvements. It is concluded that this project will have little effect on the pollution problem in Point Judith Pond.

It should be noted, however, that establishment of additional small boat anchorage areas, such as the Inner Harbor Anchorage, Little Comfort Island Anchorage, and the Snug Harbor Anchorage, may require that the surrounding areas be closed to the taking of shellfish. Such action would be in conformance with the U. S. Public Health Service recommendations.

Yours very truly,

Carleton A. Maine

Carleton A. Maine, Chief
Division of Water Pollution Control

CAM:ep

cc: Mr. Earl J. Anderson
Mr. Henry Ise

EXHIBIT NO. 4

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
DEPARTMENT OF NATURAL RESOURCES
VETERANS' MEMORIAL BUILDING, PROVIDENCE, R. I. 02903

FREDERICK C. LEES
DIRECTOR

DIVISIONS OF
Parks and Recreation
Conservation
Agriculture
Harbors and Rivers
Planning and Development
Enforcement

DIVISION OF HARBORS & RIVERS
301 Roger Williams Bldg.
Prov. R. I. 02908

February 28, 1966

Division Engineer
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, *Massachusetts*

Attention: Mr. John Wm. Leslie, Chief, Engineering Division

Dear Sir:

I have reviewed the description and preliminary plan of the proposed Water Resources Development Project at Point Judith, Rhode Island, prepared by your office. The project involves a multiple-purpose plan of improvement:- providing (1) protection against hurricane flooding and (2) shore erosion control for the area from Matunuck Beach in South Kingstown to high ground east of Sand Hill Cove Beach in Narragansett, a distance of about three and one-half miles; and (3) improvement of existing navigation channels and anchorages, and development of new channels and anchorages from Point Judith Harbor of Refuge to Wakefield.

The proposed design characteristics of the component parts of the project:- earth and rock dikes, revetments, breachway control structure, channels and anchorages, appear to be satisfactory. The project should prove beneficial, not only for the rehabilitation and stabilization of the extensive shore line; protection of the area from storm-induced flooding; and improved navigation facilities for the important fishing industry as well as pleasure boating; it should also do much to reinforce the economy of this section of the state.

Thank you for the opportunity to submit my comments.

Sincerely yours,

Henry Isé, Chief Engineer and
Chief, Division of Harbors & Rivers

HI:mp

EXHIBIT NO. 5

NARRAGANSETT
TOWN COUNCIL

NARRAGANSETT, RHODE ISLAND

March 31, 1966

John Wm. Leslie
Chief, Engineering Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

At the regular monthly meeting of the Town Council of the Town of Narragansett held Wednesday, March 23, 1966 the Council President, Louis J. Zanella discussed the Point Judith Pond Hurricane Project and what action should be taken by the Town of Narragansett to continue this phase and after consideration thereof it was

VOTED: That the Town Council of the Town of Narragansett agree in principle on the concept of the Point Judith Pond Hurricane Plan as designed by the Corps of Engineers, New England Division but object to the proportionate share that has to be paid by the Town of Narragansett and it is further

VOTED: That the Town Clerk be instructed to send a telegram to John Wm. Leslie, Corps of Engineers, 424 Trapelo Road, Waltham, Massachusetts and to Mr. Henry Ise, Chief, Division of Harbors and Rivers, Providence, Rhode Island recording the Council's action on this proposed plan.

Very truly yours,

John A. Mulligan
Council Clerk

cc: Ise

EXHIBIT NO. 6

Town of South Kingstown, R. I.

TOWN CLERK'S OFFICE

CLERK OF TOWN COUNCIL AND PROBATE COURT

Wakefield, Rhode Island

FOSTER R. SHELDON
TOWN CLERK & PROBATE CLERK
TEL. 783-2511

March 23, 1966

Mr. John Wm. Leslie, Chief,
Engineering Division,
U. S. Army Engineer Division,
New England Corps of Engineers,
424 Trapelo Road,
Waltham, Mass.

Dear Sir: Re: File No. NEDED-D

You are hereby notified that the Town Council of the Town of South Kingstown, R. I. wishes to express a continuing interest in the MULTI-PURPOSE PT. JUDITH WATER RESOURCES PROJECT.

Very truly yours,

Ralph W. Browning

Ralph W. Browning,
President,
South Kingstown Town Council.

RWB/ASC

EXHIBIT NO. 7

UNITED STATES
DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
John F. Kennedy Federal Building
Boston, Massachusetts 02203

June 29, 1966

Mr. John Wm. Leslie
Chief, Engineering Division
U. S. Army Engineer Division
New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Mr. Leslie:

This is in response to your letter of 2 February 1966 requesting comments on the proposed Point Judith, Rhode Island, Water Resources Development Project. The project proposes the deepening of the channel from State Beach to Wakefield, as well as to Snug Harbor and to Little Comfort Island. It would provide additional anchorage areas at the Fish Plant and at Wakefield with new anchorage areas at Snug Harbor and at Little Comfort Island. The plan also proposes sanddune restoration, beach raising and widening, and a breachway control structure.

Preliminary evaluation by our staff indicates that the project itself will not create or intensify pollution; but increased boat usage engendered by the deepened navigation channels and enlarged anchorage areas may increase pollution, thereby necessitating the closing of this pond to the taking of shellfish.

The Corps of Engineers estimates that upon the completion of the project, Point Judith Pond will be used by approximately 800 boats.

There is a shellfish closure in existence for the Upper Pond Area; therefore, the enlargement of the anchorage in the closed area will have little effect on state and federal shellfish programs. However, there are shellfish beds in the Snug Harbor and Little Comfort Island Areas which would be subject to pollution from increased boating activities, including anchorage of boats with flush toilets, and the closure of these areas for shellfish harvesting may become necessary.

EXHIBIT NO. 8

It appears that if marinas or boat anchorage areas are provided at Snug Harbor and Little Comfort Island, adequate provision should be made for the storage and treatment of sewage from vessels. This might be done by requiring boats with toilets using these anchorages to be equipped with retention tanks. Sewage from these tanks could then be discharged by pumping at a central servicing point.

We appreciate the opportunity to review this proposed project.

Sincerely yours,

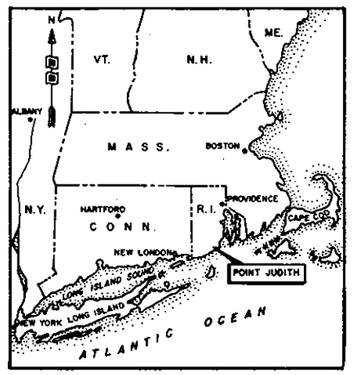
Walter M. Newman

Walter M. Newman, Chief
Water Resources Development Activities
Federal Water Pollution Control
Administration

EXHIBIT NO. 8

CORPS OF ENGINEERS

U.S. ARMY



LOCATION MAP

SCALE IN MILES 25 0 25 50

WAKEFIELD (BUSINESS CENTER)

ENLARGE ANCHORAGE 8'

NARRAGANSETT PIER

SOUTH KINGSTOWN

NARRAGANSETT

DEEPEN CHANNEL AND ANCHORAGE 8'

SNUG HARBOR

CHANNEL & ANCHORAGE 8'

ENLARGE ANCHORAGE 10'

ANCHORAGE 8'

CHANNEL 10'

JERUSALEM

GALILEE

MATUNUCK

DIKE AND BEACH FILL

BREACHWAY CONTROL STRUCTURE

SUCCOTASH ROAD TO BE RELOCATED BY OTHERS

DIKE

BULKHEAD (PRECAST CONCRETE)

REBUILD 5 GROINS

STRAIGHTEN & DEEPEN ENTRANCE CHANNEL 20'

SAND HILL COVE

POINT JUDITH NECK

BLACK PT.

SCARBOROUGH STATE BEACH

FORT NATHANIEL GREENE (U.S. GOVT.)

COAST GUARD STATION POINT JUDITH

Point Judith Harbor of Refuge

BREAKWATER

Block Island Sound

Rhode Island Sound

ATLANTIC OCEAN

PLATE 2 | PLATE 3 | PLATE 4 | PLATE 5 | PLATE 6 | PLATE 7 | PLATE 8 | PLATE 9 | PLATE 10 | PLATE 11

DESIGN FLOOD LINE

STATE OWNED LAND

SCALE IN FEET 1000 0 1000 2000

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

SUBMITTED:

CHIEF, SECTION

REVIEWED:

PROJECT ENGINEER

APPROVED:

CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT

POINT JUDITH R.I.

GENERAL PLAN

POINT JUDITH RHODE ISLAND

APPROVED DATE

CHIEF, ENGINEERING DIVISION

SCALE

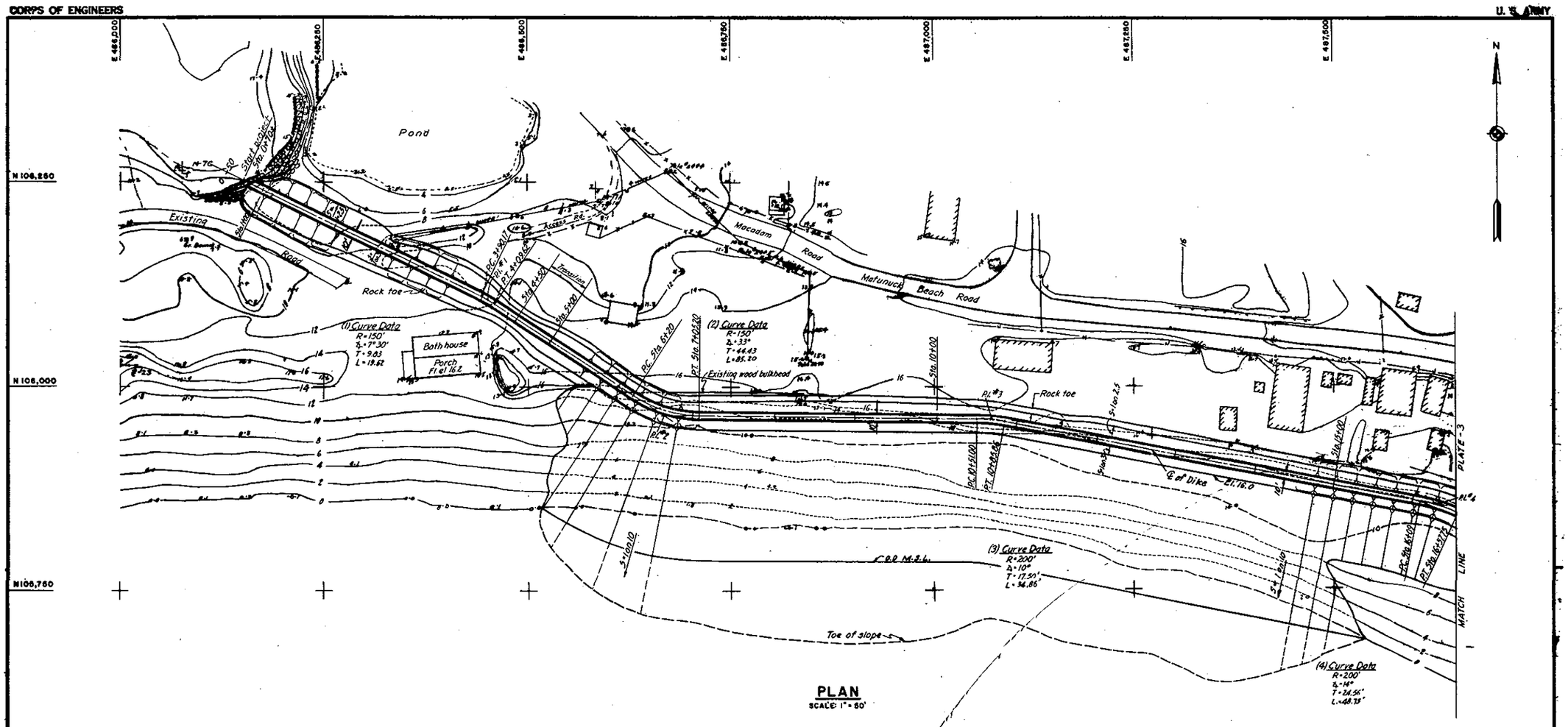
SPEC. NO. CIV. ENG. 18-016-

DRAWING NUMBER 1

SHEET

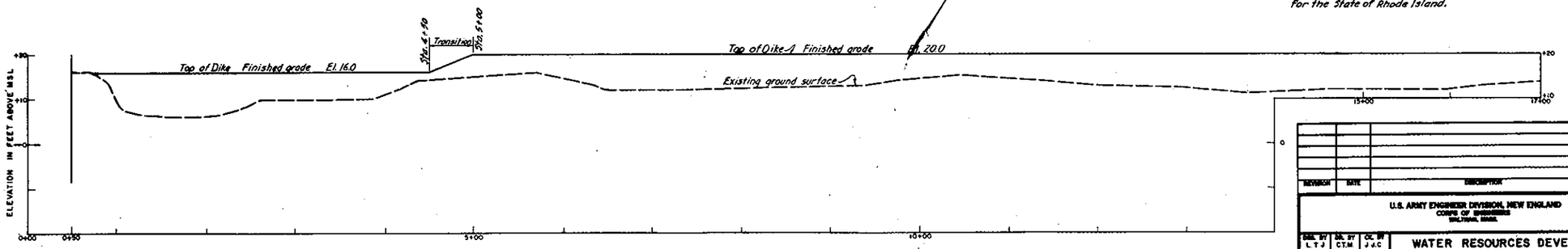
PLATE NO.2-1

CORPS OF ENGINEERS U. S. ARMY



PLAN
SCALE 1" = 80'

GENERAL NOTES
All elevations refer to Mean Sea Level Datum.
Coordinates refer to the Mercator Grid System for the State of Rhode Island.



PROFILE ALONG ℄ OF DIKE
SCALE: HOR 1" = 50'
VERT. 1" = 10'

GRAPHIC SCALES
1" = 10'
1" = 50'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
L.T.J	C.T.M	J.J.C

SUBMITTED: CHIEF, SECTION
REVIEWED: CHIEF, DESIGN BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED DATE

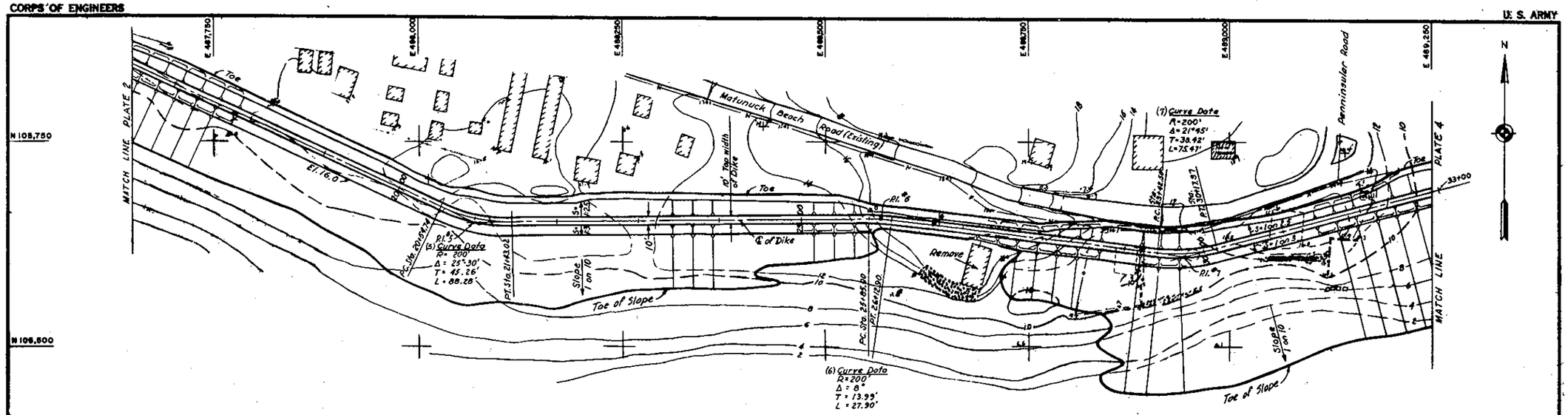
WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
PLAN AND PROFILE NO. 1
POINT JUDITH RHODE ISLAND

SCALE AS SHOWN SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 2-2

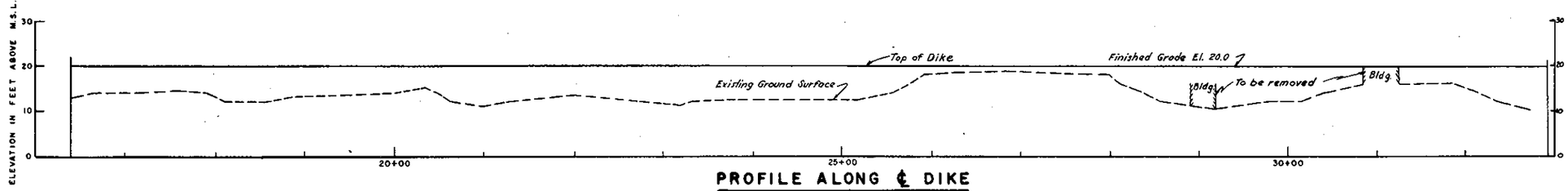
CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE: 1"=50'



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1"=50'
VER. 1"=10'

GRAPHIC SCALES

1"=10' 10' 0 10' 20'

1"=50' 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.J.C. | DR. BY E.J.K. | CK. BY

SUBMITTED: CHIEF, SECTION

REVIEWED: PROJECT ENGINEER

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: CHIEF, DIVISION (OFFICE)

WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I
PLAN AND PROFILE NO. 2

POINT JUDITH RHODE ISLAND

DATE

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-016-

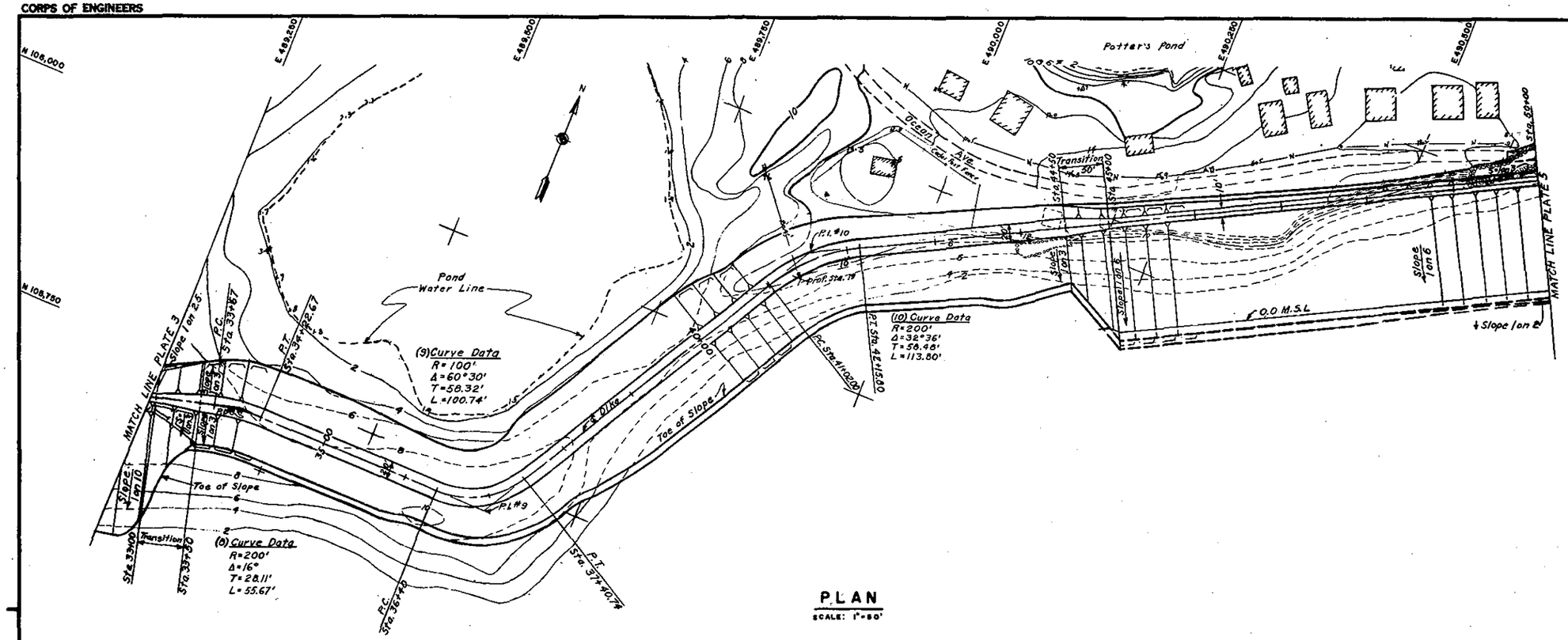
DRAWING NUMBER

SHEET

PLATE NO. 2-3

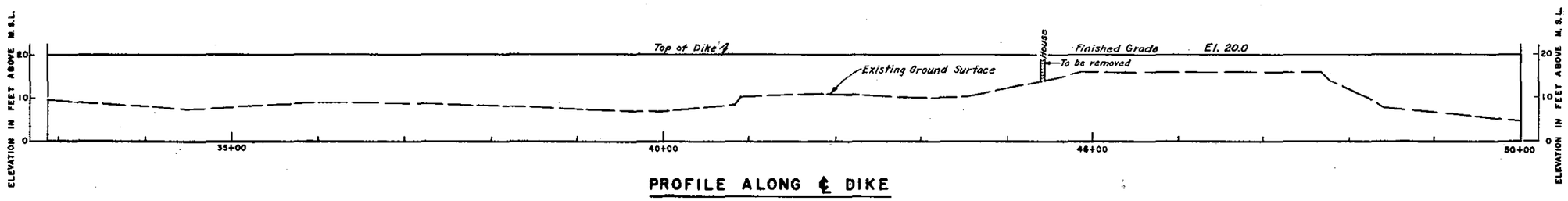
CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE: 1"=50'



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1"=50'
VER. 1"=10'

GRAPHIC SCALES

1"=10' 10' 0 10' 20'

1"=50' 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY L.T.J. | DR. BY E.J.K. | CK. BY

SUBMITTED:

CHIEF, SECTION

REVIEWED:

PROJECT ENGINEER

APPROVED:

CHIEF, ENGINEERING DIVISION

WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
PLAN AND PROFILE NO. 3

POINT JUDITH RHODE ISLAND

APPROVED: DATE:

SCALE AS SHOWN SPEC. NO. CIV. ENG. 19-010-

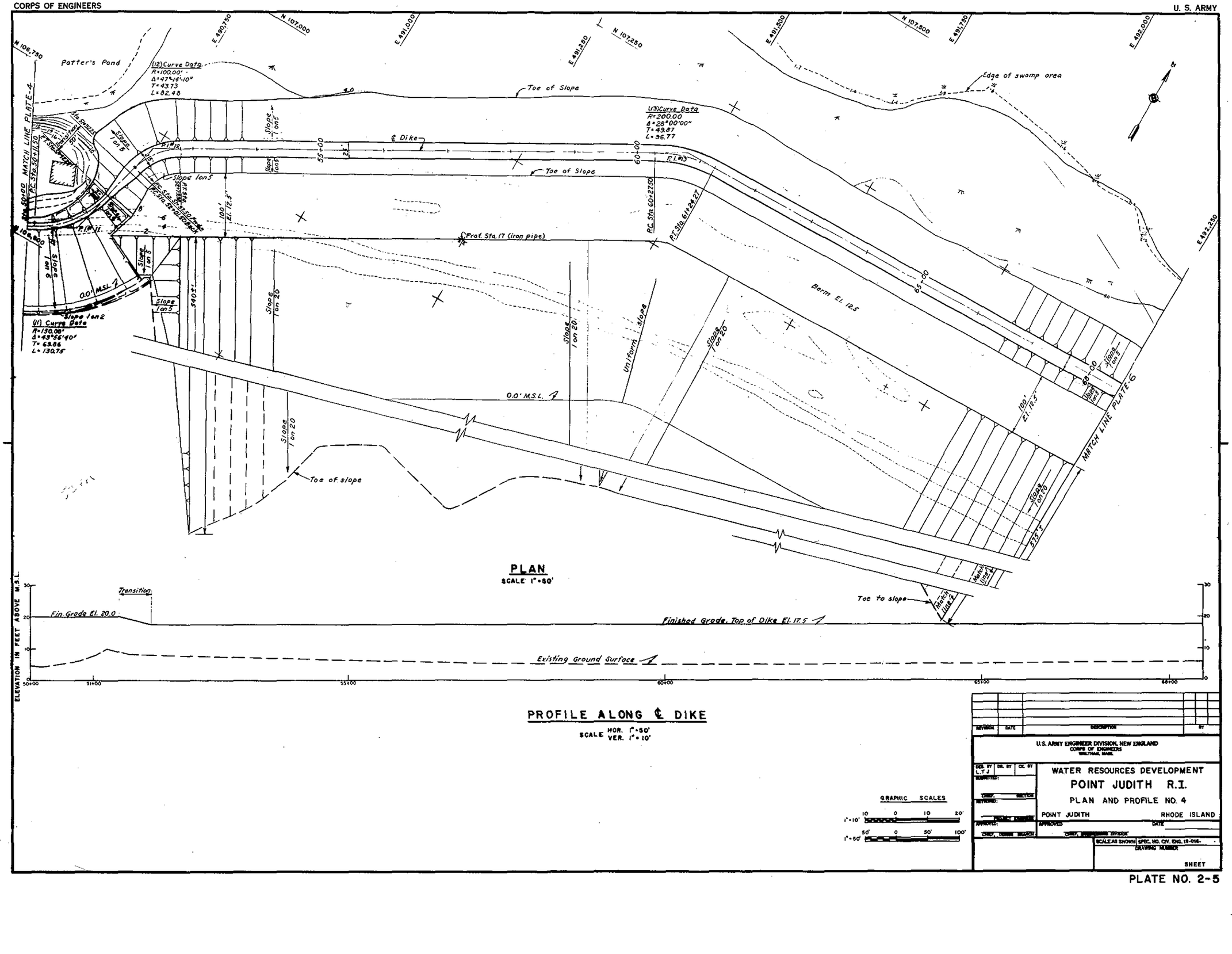
DRAWING NUMBER

SHEET

PLATE NO. 2-4

CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE 1"=50'

PROFILE ALONG ℄ DIKE

SCALE HOR. 1"=50'
VER. 1"=10'

GRAPHIC SCALES

1"=10' 10 0 10 20'

1"=50' 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY L.T.J | DR. BY | CK. BY

SUBMITTED:

CHIEF, SECTION

RECOMMENDED:

PROJECT MANAGER

APPROVED:

CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT

POINT JUDITH R.I.

PLAN AND PROFILE NO. 4

POINT JUDITH RHODE ISLAND

APPROVED DATE

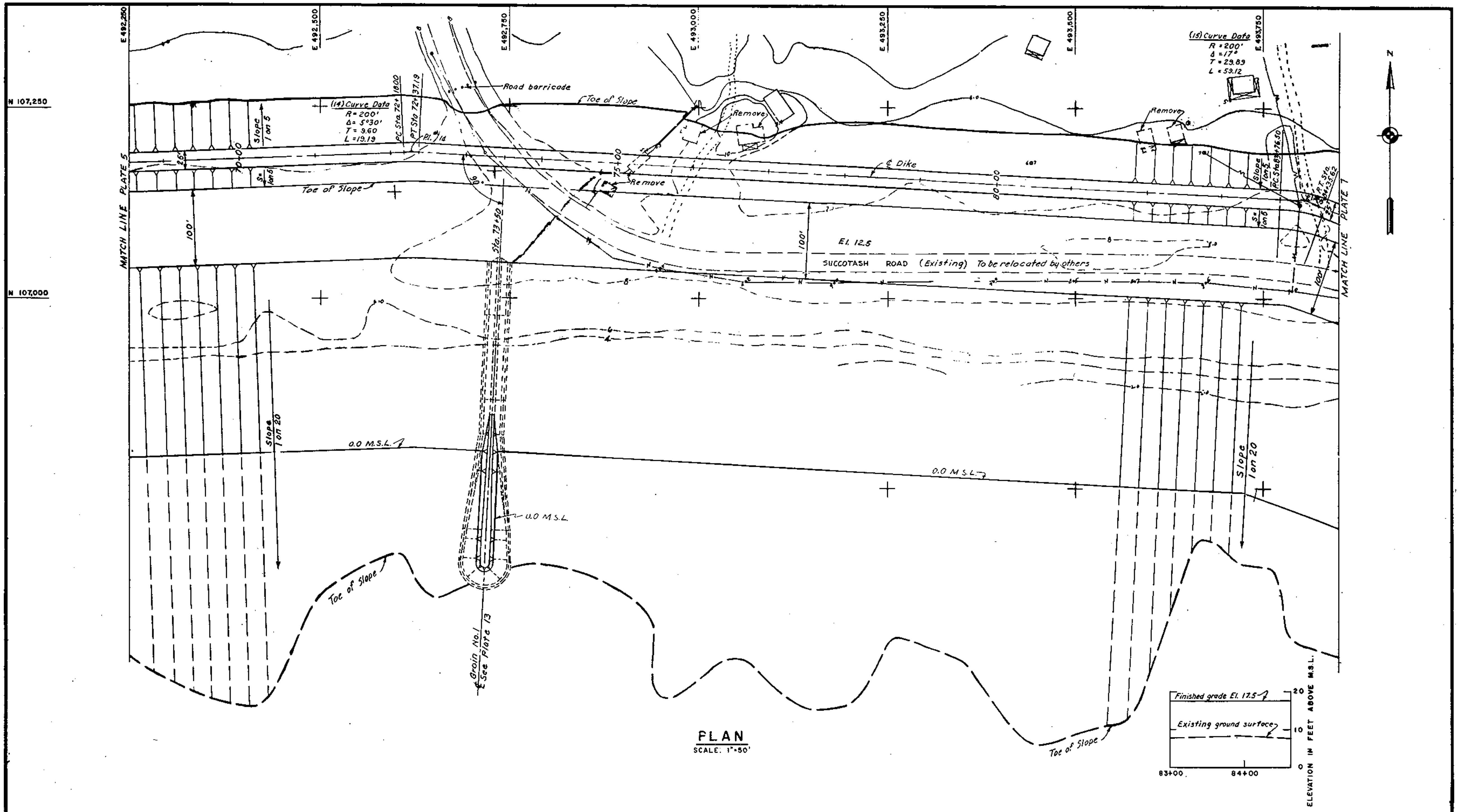
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 18-016-

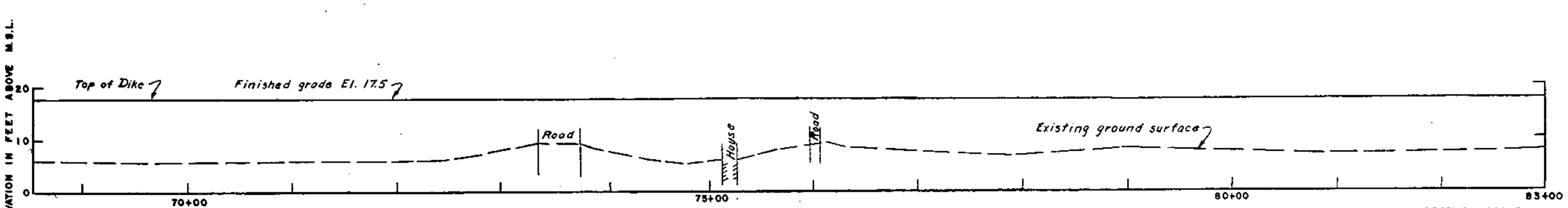
DRAWING NUMBER

SHEET

PLATE NO. 2-5



PLAN
SCALE: 1"=50'



PROFILE ALONG ℄ DIKE
SCALE. HOR. 1"=50'
VER 1"=10'

GRAPHIC SCALES
1"=10' 10' 0 10' 20'
1"=50' 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

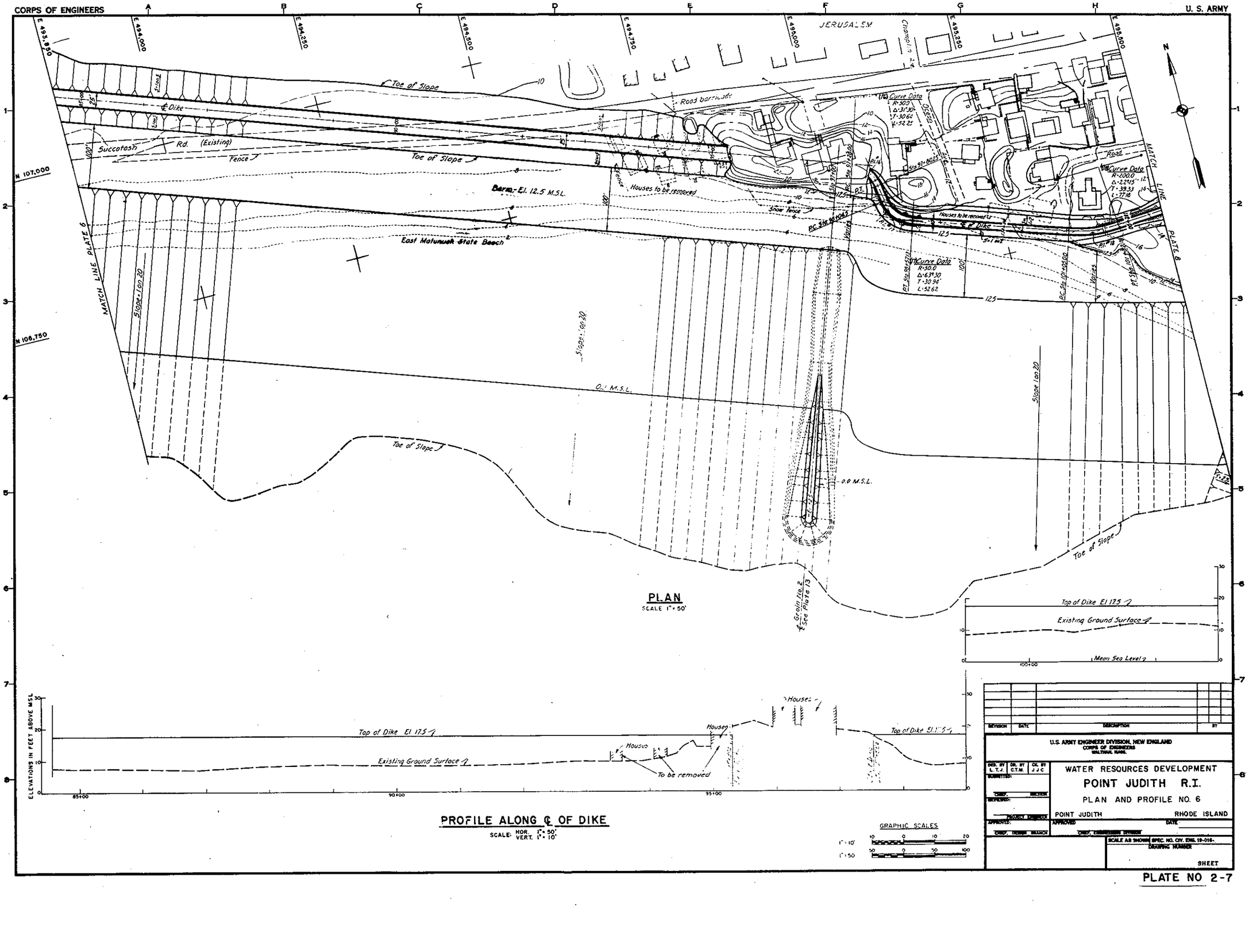
WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
PLAN AND PROFILE NO. 5
POINT JUDITH - RHODE ISLAND

SHEET

PLATE NO. 2-6

CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE 1" = 50'

PROFILE ALONG ℄ OF DIKE

SCALE: HOR. 1" = 50'
VERT. 1" = 10'

GRAPHIC SCALES

1" = 10'

1" = 50'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
L.T.J.	C.T.M.	J.J.C.

SUBMITTED:

CHIEF, SECTION

REVIEWED:

DISTRICT ENGINEER

APPROVED:

CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT

POINT JUDITH R.I.

PLAN AND PROFILE NO. 6

POINT JUDITH RHODE ISLAND

APPROVED DATE:

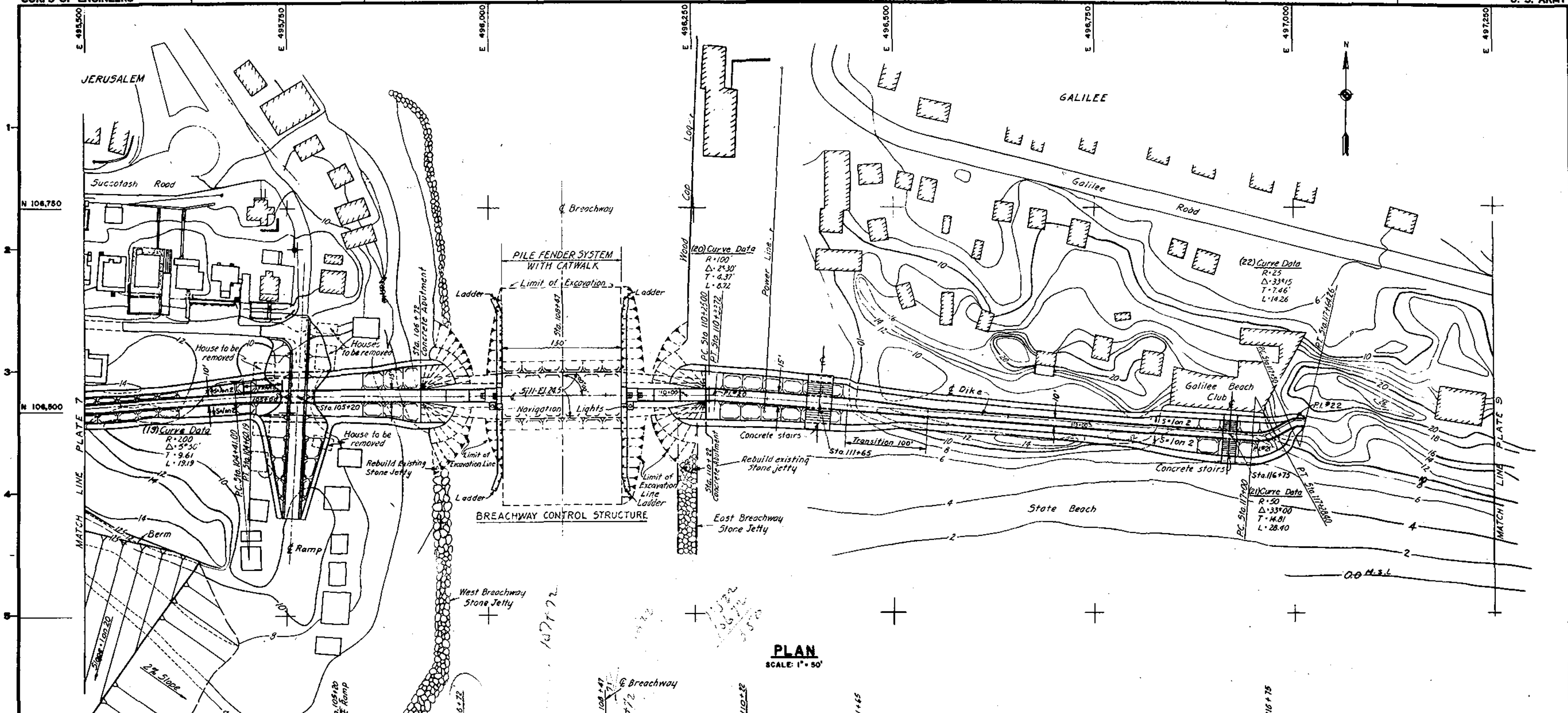
CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN SPEC. NO. CIV. ENG. 19-016-

DRAWING NUMBER

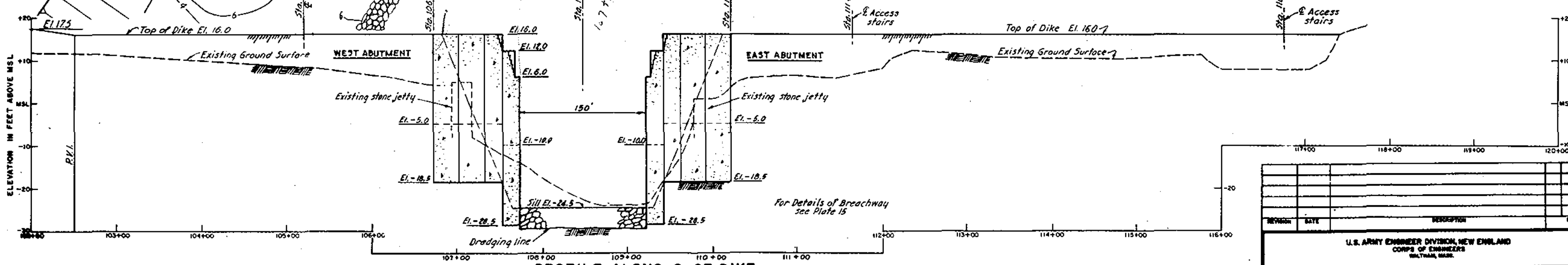
SHEET

PLATE NO 2-7



PLAN

SCALE: 1" = 50'



PROFILE ALONG ℄ OF DIKE

SCALE: HOR. 1" = 50' VERT. 1" = 10'

GRAPHIC SCALES

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT

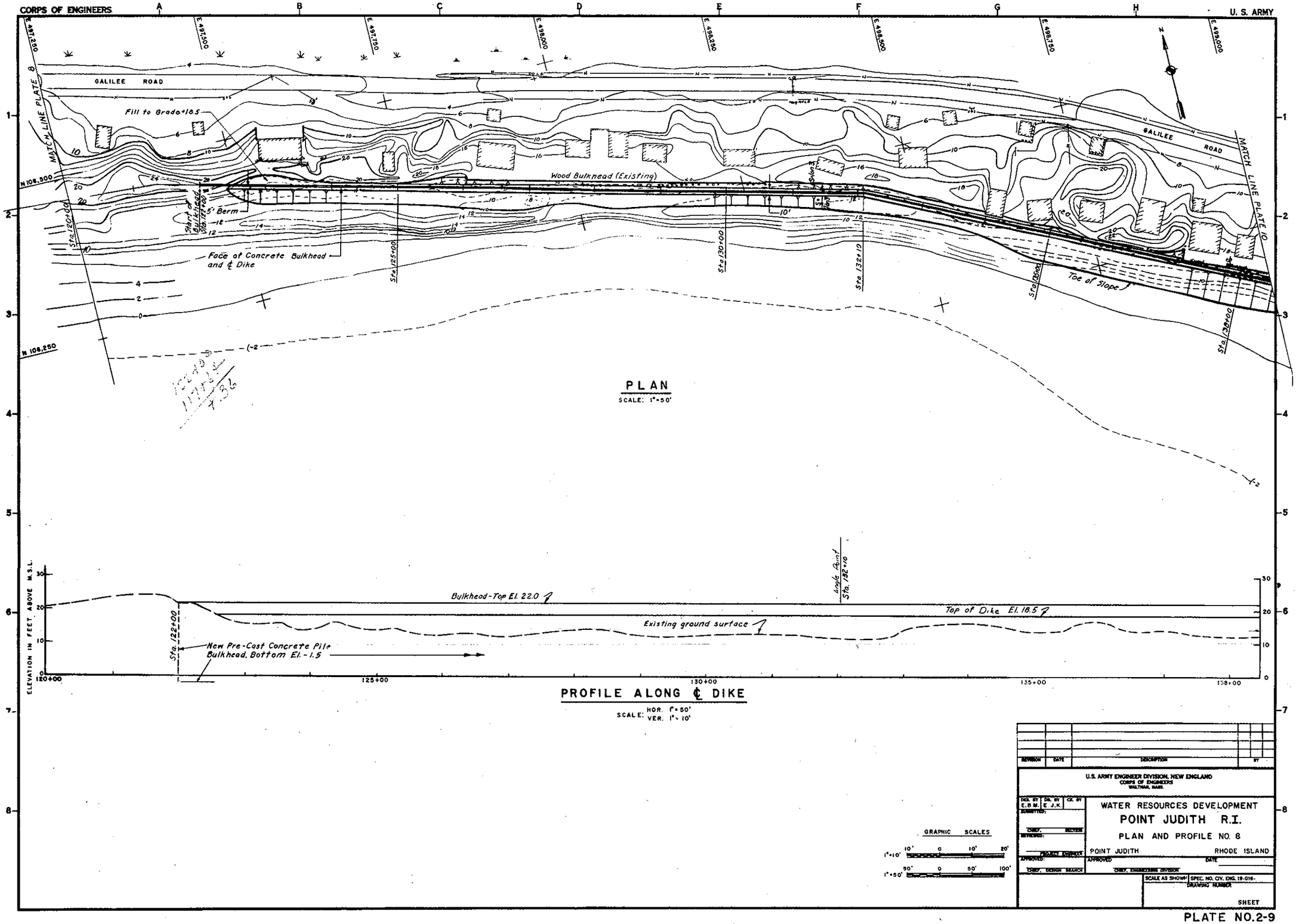
POINT JUDITH R.I.

PLAN AND PROFILE NO. 7

POINT JUDITH — RHODE ISLAND

PLATE NO. 2-8

CORPS OF ENGINEERS — U. S. ARMY



PLAN

SCALE: 1"=50'

PROFILE ALONG ℄ DIKE

SCALE: HOR. 1"=50'
VER. 1"=10'

GRAPHIC SCALES

1"=10' 10' 0 10' 20'

1"=50' 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY E.R.M. | DR. BY E.J.K. | CK. BY

SUBMITTED:

CHIEF, SECTION

RECOMMENDED:

PROJECT ENGINEER

APPROVED:

CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT

POINT JUDITH R.I.

PLAN AND PROFILE NO. 8

POINT JUDITH RHODE ISLAND

APPROVED DATE

CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-016-

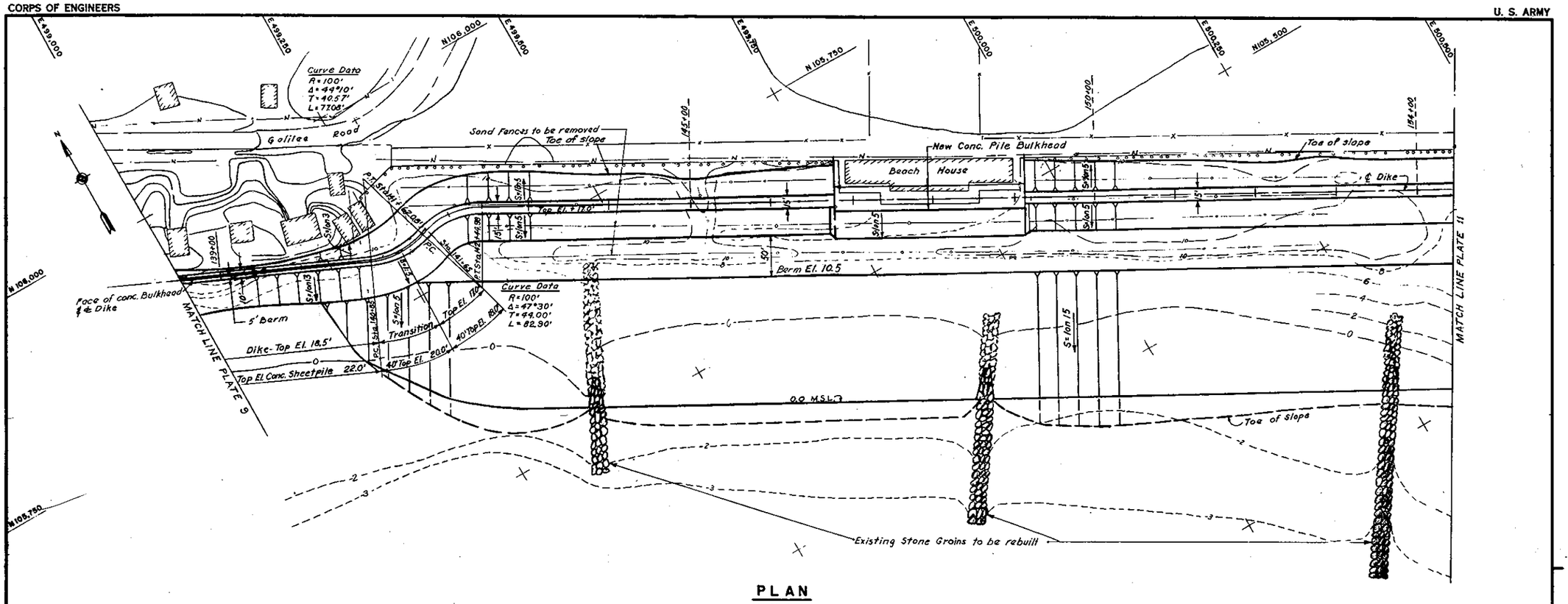
DRAWING NUMBER

SHEET

PLATE NO. 2-9

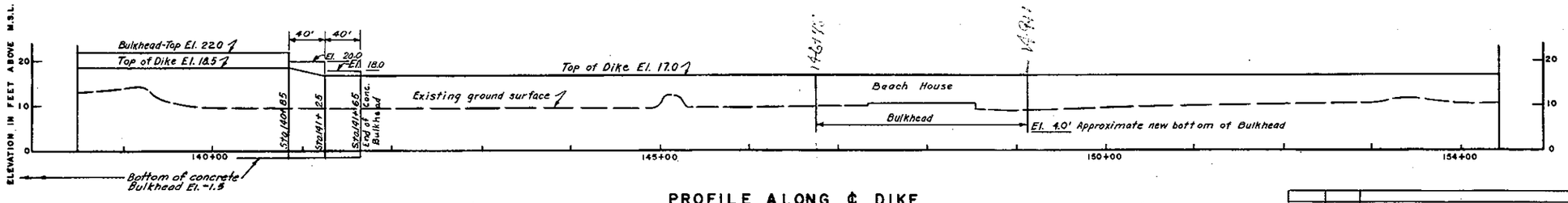
CORPS OF ENGINEERS

U. S. ARMY



PLAN

SCALE: 1"=50'



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1"=50'
VER. 1"=10'

GRAPHIC SCALES

1"=10' 10' 0 10' 20'

1"=50' 60' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY E. J. K. | CK. BY

SUBMITTED: CHIEF, SECTION

REVIEWED: PROJECT ENGINEER

APPROVED: CHIEF, DESIGN BRANCH

APPROVED: CHIEF, ENGINEERING DIVISION

DATE:

WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
PLAN AND PROFILE NO. 9

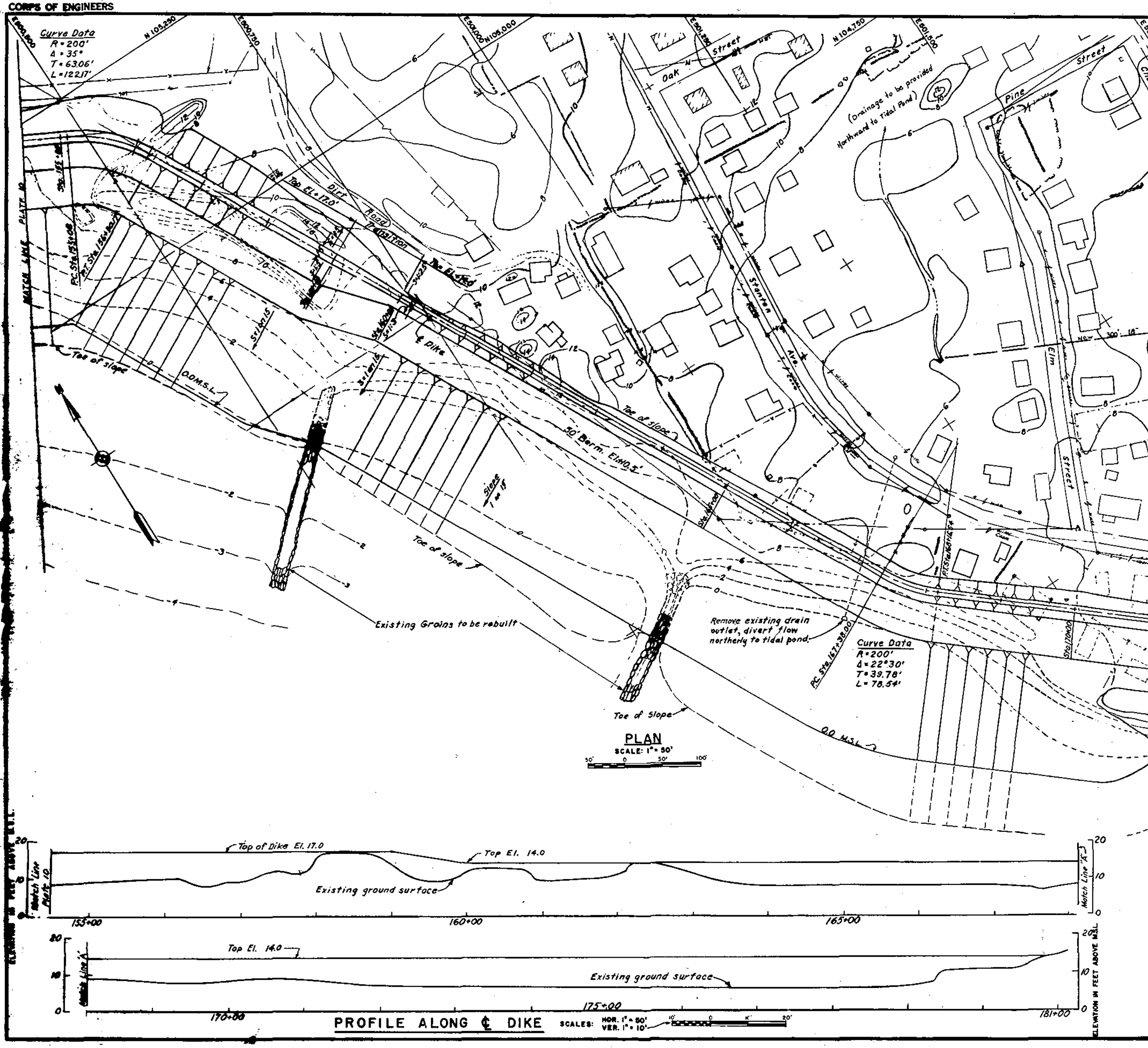
POINT JUDITH RHODE island

SCALE AS SHOWN | SPEC. NO. CIV. ENG. 19-018-

DRAWING NUMBER

SHEET

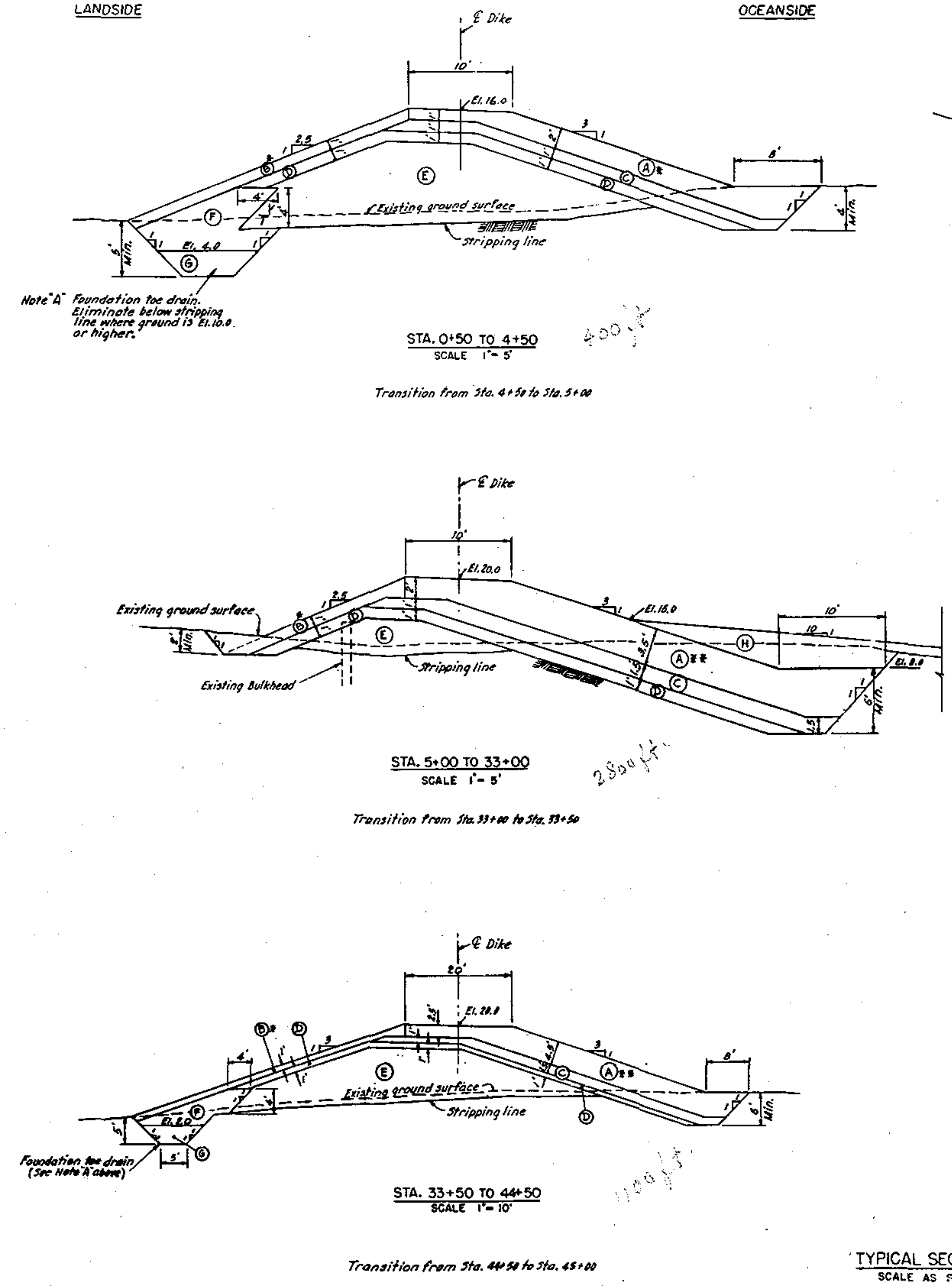
PLATE NO. 2-10

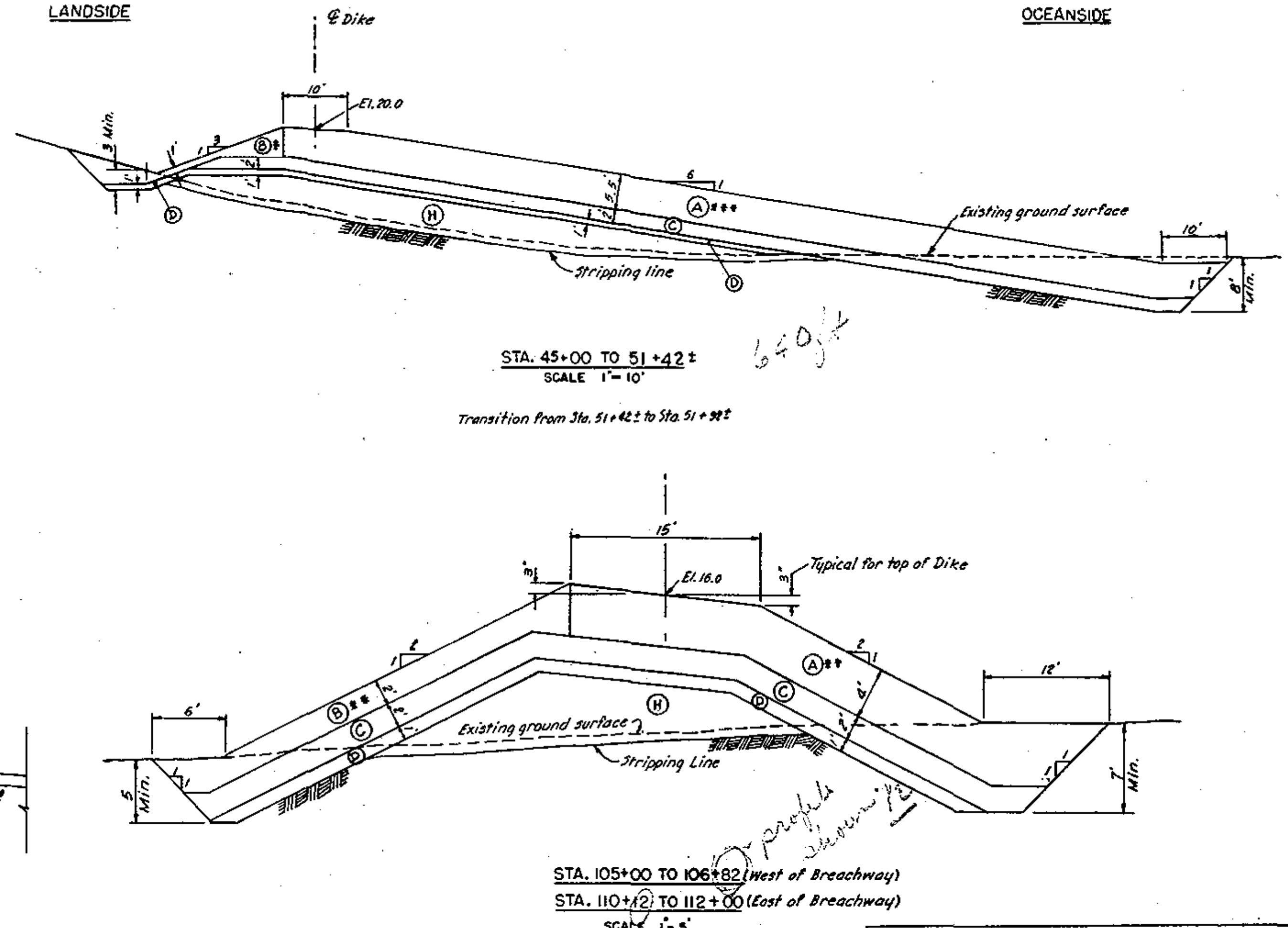

Curve Data
R=200'
Δ=35°
T=63.06'
L=122.17'
Oak Street
Pine Street
Chestnut Ave.
Stanton Ave.
Elm Street
(Drainage to be provided Northward to tidal Pond)
Top El.=17.0'
Dirt Road Transition
¢ Dike
Toe of slope
O.D.M.S.L.
Waste fill-Grade to El. 6.0
Slope to drain
Exist. Wall, to be removed.
Edge water
End of Project
Curve Data
R=200'
Δ=41°20'
T=75.44'
L=144.28'
Curve Data
R=100'
Δ=98°30'
T=116.06
L=171.91'
50' Berm El.=10.5'
Slope 1 on 15
Existing Groins to be rebuilt
Remove existing drain outlet, divert flow northerly to tidal pond.
Curve Data
R=200'
Δ=22°30'
T=39.78'
L=78.54'
Toe of Slope
0.0 M.S.L.
MATCH LINE PLATE 10
PLAN
SCALE: 1"=50'
Top of Dike El. 17.0
Top El. 14.0
Existing ground surface
155+00
160+00
165+00
170+00
175+00
181+00
Match Line "A"
ELEVATION IN FEET ABOVE M.S.L.
PROFILE ALONG ¢ DIKE
SCALES: HOR. 1"=50' VER. 1"=10'

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
PLAN AND PROFILE NO. 10
POINT JUDITH RHODE ISLAND

CORPS OF ENGINEERS — U. S. ARMY





MATERIALS LEGEND		
DESIGNATION	TYPE	ITEM NO.
(A)	ROCK ARMOR * 500 LBS. ** 1 TON *** 1 — 5 TON	
(B)	ROCK PROTECTION * 50 — 500 LBS. ** 1 — 2 TON	
(C)	ROCK BEDDING 50 TO 500 LBS.	
(D)	GRAVEL BEDDING	
(E)	COMPACTED EARTH FILL	
(F)	COMPACTED GRAVEL FILL	
(G)	UNCOMPACTED GRAVEL FILL	
(H)	SAND FILL	
(I)	GROIN, CORE. (Assorted Stone sizes, chinked.)	
(J)	DUMPED EARTH FILL	

* Denotes weights of Stone. See Sections.

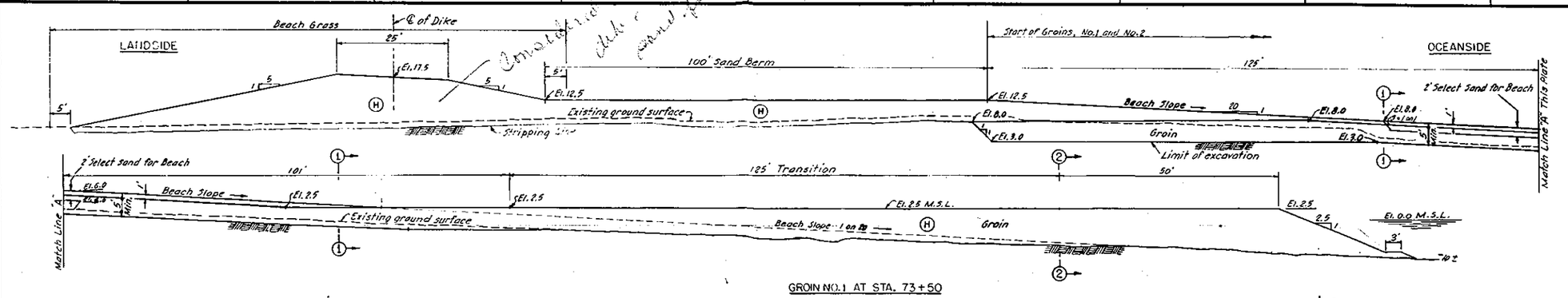
TYPICAL SECTIONS
SCALE AS SHOWN

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

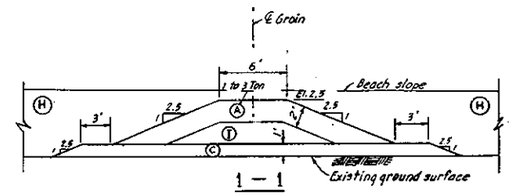
WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I
TYPICAL SECTIONS NO. 1
POINT JUDITH — RHODE ISLAND

PLATE NO. 2-12

CORPS OF ENGINEERS — U. S. ARMY

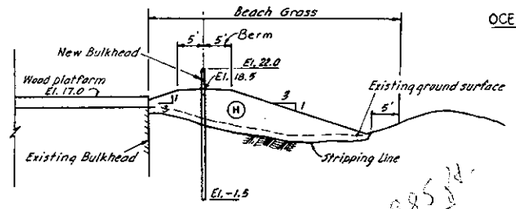


GROIN NO. 1 AT STA. 73+50
STA. 51+92 TO 95+50 (DIKE)
SCALE 1" = 10'
Typical for Groin No. 2 at Sta. 97+00

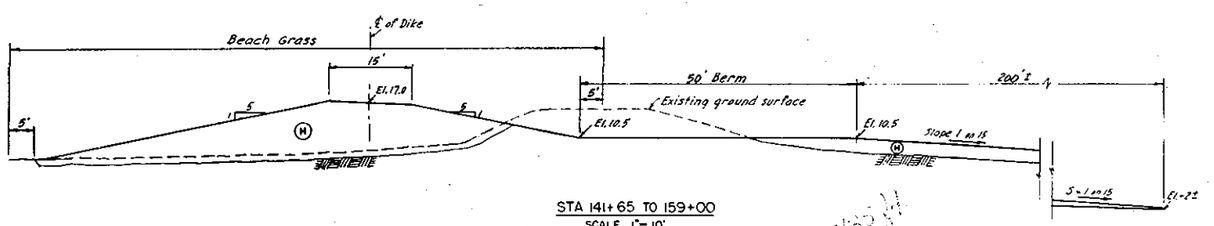


1 — 1

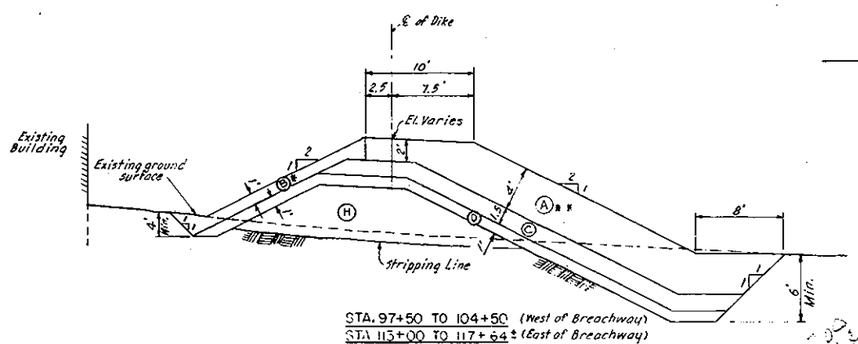
GROIN SECTION



STA. 122+00 TO 140+85
SCALE 1" = 10'
Transition from Sta. 140+85 to Sta. 141+65

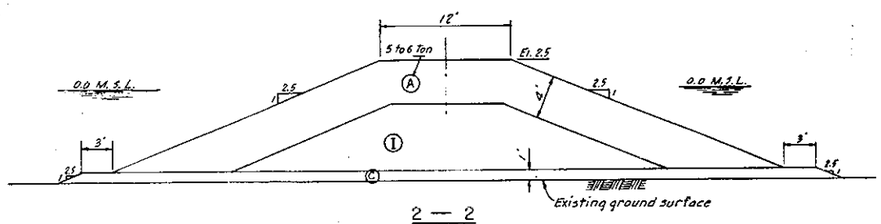


STA 141+65 TO 159+00
SCALE 1" = 10'
Except Beach House area - Sta. 146+78 to 149+12
Transition from Sta. 139+00 to Sta. 160+00



STA. 97+50 TO 104+50 (West of Breachway)
STA 113+00 TO 117+64 ± (East of Breachway)
Transition from:
Sta. 104+50 to Sta. 105+00 (West of Breachway)
Sta. 112+00 to Sta. 113+00 (East of Breachway)
Dike Elev. 17.5 at Sta. 102+00
& Elev. 16.0 at Sta. 102+50

TYPICAL SECTIONS
SCALE AS SHOWN



2 — 2

GROIN SECTIONS
SCALE 1" = 5'
Typical for Groins No. 1 and No. 2

NOTES

For Materials see Legend on Plate No. 12
For location of Groins see Plate No. 6 and Plate No. 7

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED:
CHIEF, SECTION
REVIEWED:
PROJECT ENGINEER
APPROVED:
CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
TYPICAL SECTIONS NO. 2
POINT JUDITH — RHODE ISLAND
APPROVED — DATE
CHIEF, ENGINEERING DIVISION

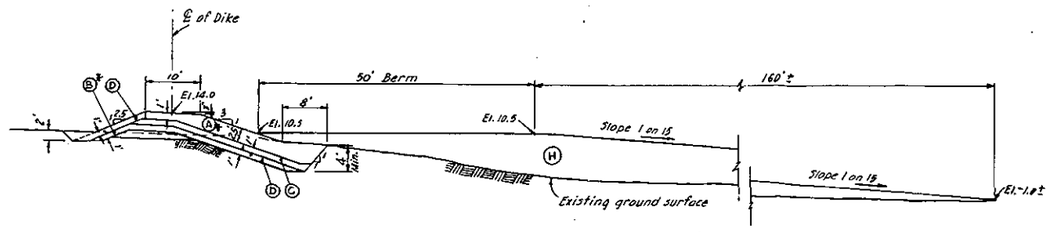
SCALE | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 2-13

CORPS OF ENGINEERS — U. S. ARMY

LANDSIDE

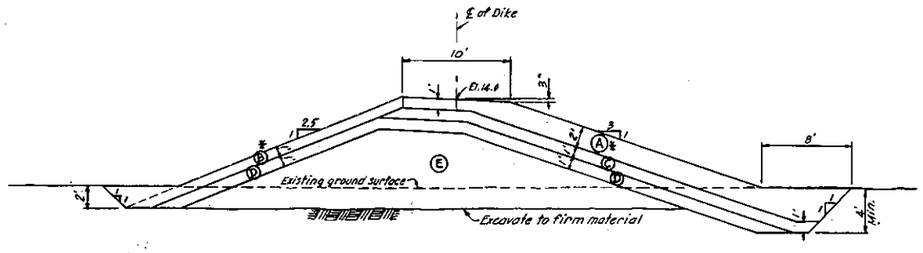
OCEANSIDE



STA. 160+00 TO STA. 174+00
SCALE 1" = 10'

Transition

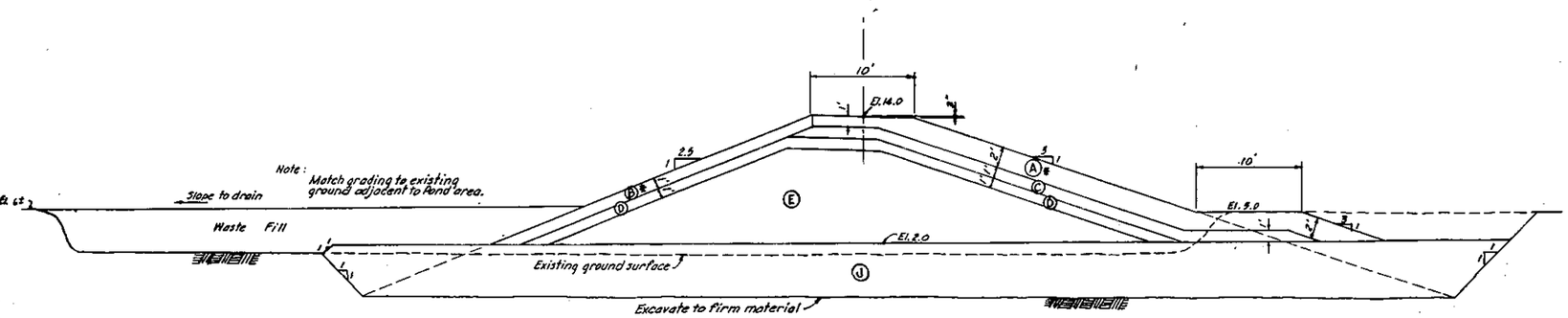
1400 ft.



STA. 174+00 TO STA. 175+50
AND
STA. 177+25 TO STA. 181+00
SCALE 1" = 5'

150
375
525

Transition



STA. 175+50 TO STA. 177+25
SCALE 1" = 5'

175

TYPICAL SECTIONS
SCALE AS SHOWN

NOTES
For Materials see Legend on Plate 11.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DSN. BY | DR. BY | CK. BY

SUBMITTED: CHIEF, SECTION

REVIEWED: PROJECT ENGINEER

APPROVED: CHIEF, DESIGN BRANCH

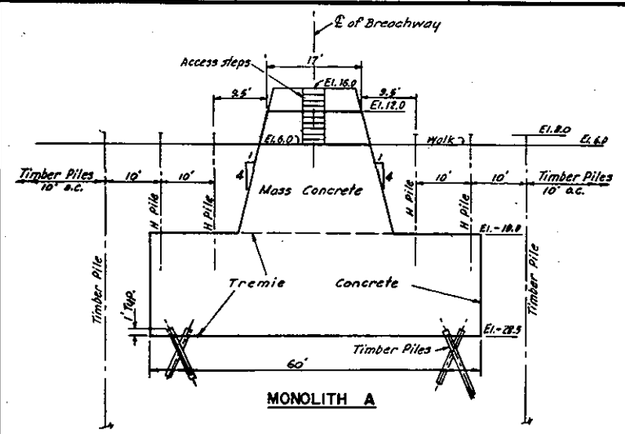
WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
TYPICAL SECTIONS NO. 3
POINT JUDITH RHODE ISLAND

APPROVED DATE
CHIEF, ENGINEERING DIVISION

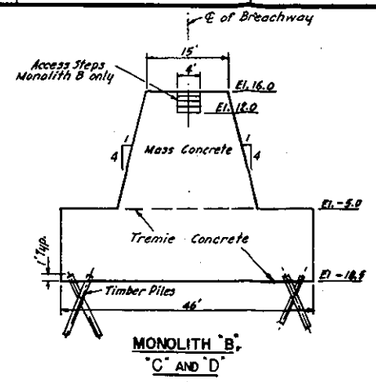
SCALE | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 2-14

CORPS OF ENGINEERS — U. S. ARMY



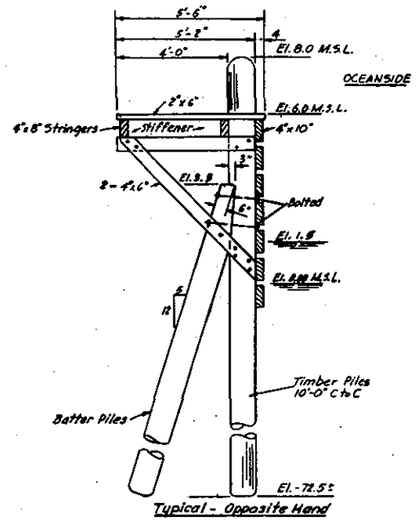
MONOLITH A



MONOLITH "B", "C" AND "D"

BREACHWAY CONCRETE DETAILS
EAST AND WEST SIDE

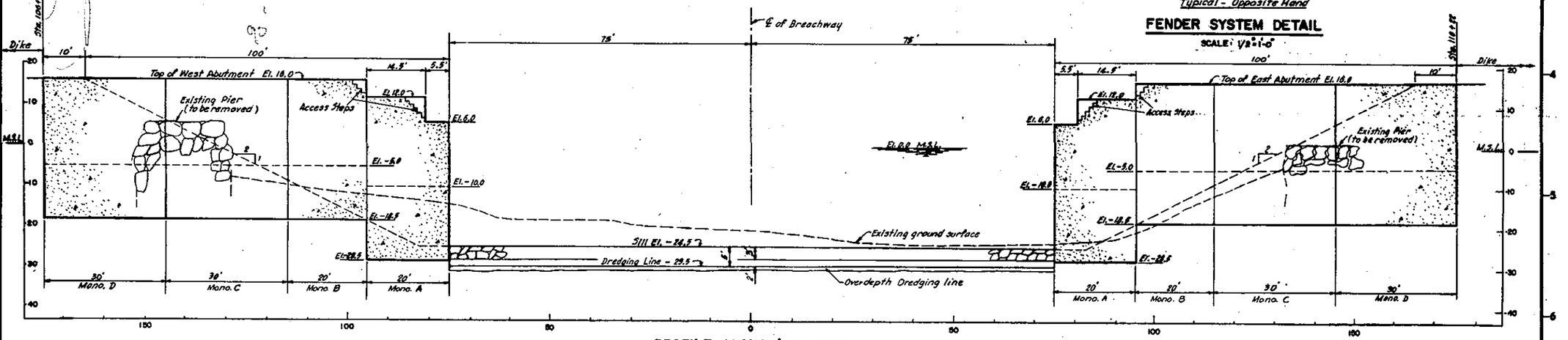
SCALE: 1" = 10'



Typical - Opposite Hand

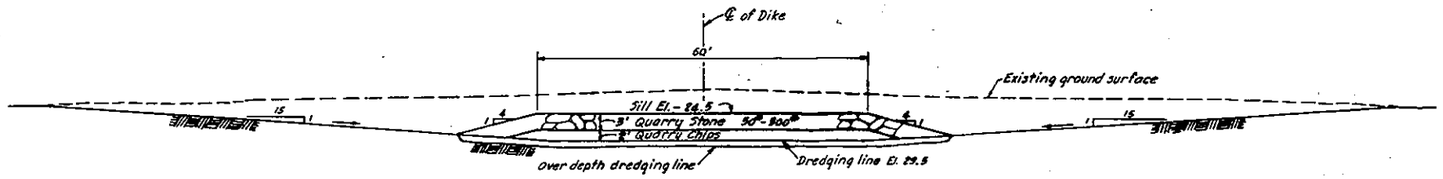
FENDER SYSTEM DETAIL

SCALE: 1/2" = 1'-0"



PROFILE ALONG ℄ BARRIER

SCALE: 1" = 10' HOR.
1" = 10' VERT.



SECTION OF SILL ALONG ℄ OF CHANNEL

SCALE: 1" = 10'

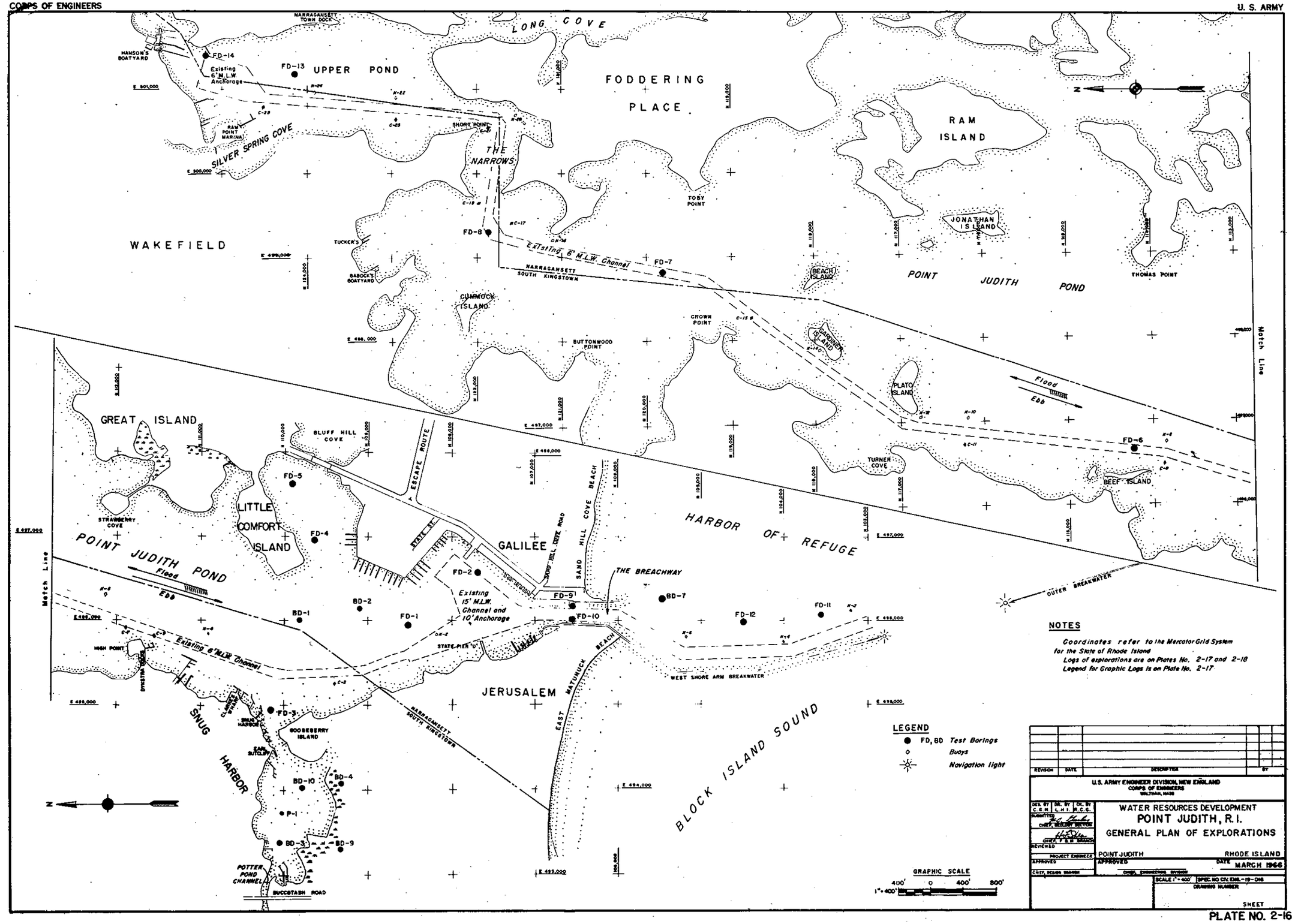
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

WATER RESOURCES DEVELOPMENT
POINT JUDITH R.I.
BREACHWAY
PROFILE AND DETAILS
POINT JUDITH RHODE ISLAND

SCALE
SHEET

PLATE NO. 2-15

CORPS OF ENGINEERS U. S. ARMY



NOTES

Coordinates refer to the Mercator Grid System for the State of Rhode Island
Logs of explorations are on Plates No. 2-17 and 2-18
Legend for Graphic Logs is on Plate No. 2-17

LEGEND

- FD, BD *Test Borings*
- *Buoys*
- *Navigation light*

GRAPHIC SCALE
400' 0 400' 800'
1" = 400'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
C.G.H.	L.H.I.	R.C.C.

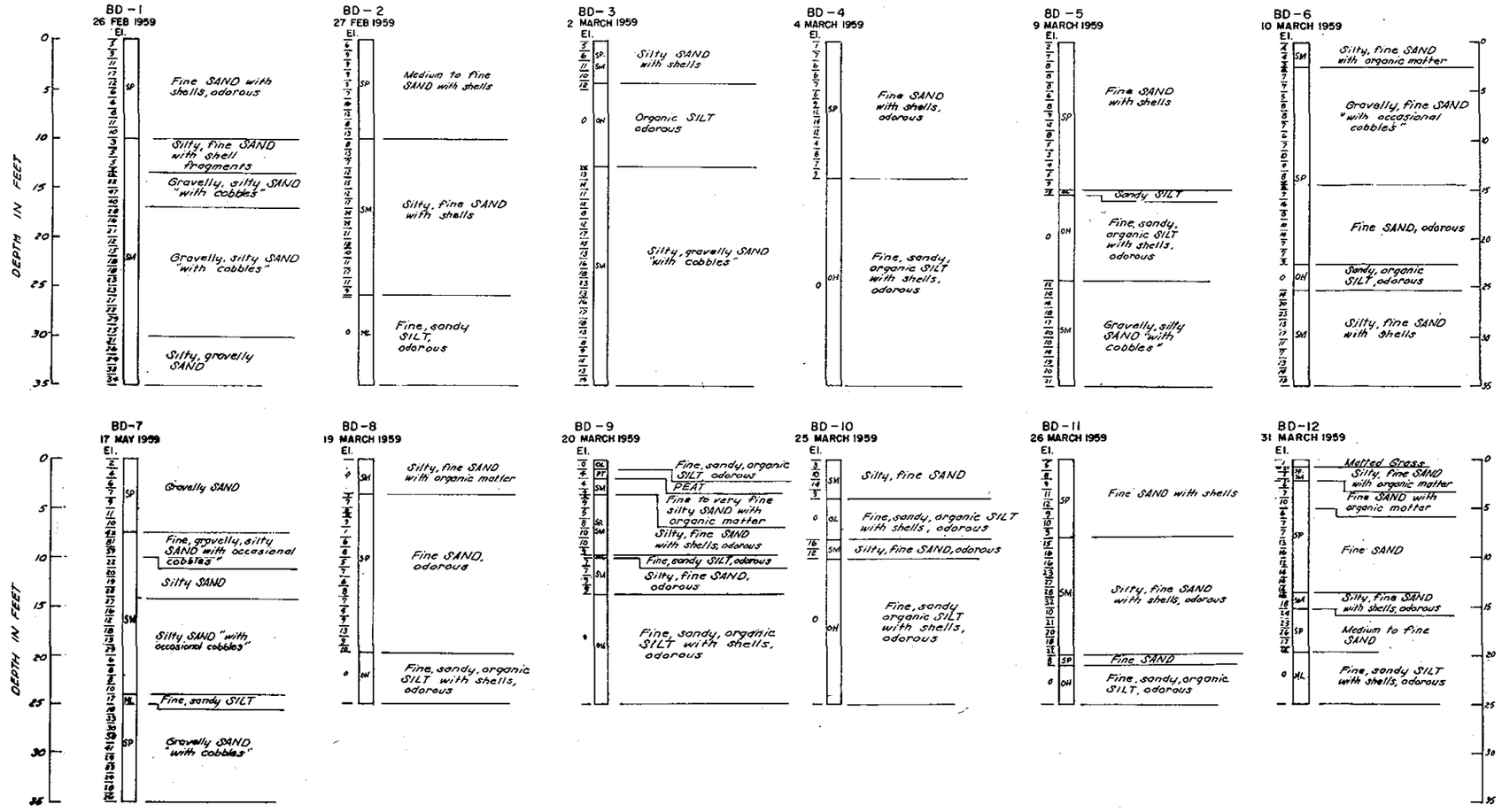
SUBMITTED
CHIEF, GEOLOGY SECTION
CHIEF, F & H BRANCH
REVIEWED
PROJECT ENGINEER
APPROVED
CHIEF, DESIGN BRANCH
CHIEF, ENGINEERING DIVISION

WATER RESOURCES DEVELOPMENT
POINT JUDITH, R.I.
GENERAL PLAN OF EXPLORATIONS
POINT JUDITH RHODE ISLAND
APPROVED DATE MARCH 1966
SCALE 1" = 400' SPEC. NO. CIV. ENG.-19-046
DRAWING NUMBER
SHEET

PLATE NO. 2-16

CORPS OF ENGINEERS

U. S. ARMY



LEGEND FOR GRAPHIC LOGS

FD, BD	Test Borings
4 MARCH 1959	Date Exploration Completed
El.	M.L.W. Elevation of ground or river bottom at time of exploration
SP	Group letter symbol according to Unified Soil Classification System
43	Number of blows per foot of penetration using a 350 pound hammer with a free fall of about 18 inches on a standard size sample spoon equipped with a beveled and sharpened drive shoe
0	Penetration by weight of tools only

NOTES

Borings BD-1 through BD-16 were made for sand borrow investigations during early project studies. Borrow explorations for the current project appear on Plates No. 2-19 and 2-20.

Locations of explorations on this sheet pertinent to this report appear on Plate No. 2-16.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY C.G.H. | DR. BY R.D.B. | CK. BY R.C.G.

SUBMITTED
CHIEF, GEOLOGY SECTION

CHIEF, F & M BRANCH

REVIEWED
PROJECT ENGINEER

APPROVED
CHIEF, DESIGN BRANCH

APPROVED
CHIEF, ENGINEERING DIVISION

WATER RESOURCES DEVELOPMENT

POINT JUDITH, R.I.

RECORD OF EXPLORATIONS NO. 1

POINT JUDITH RHODE ISLAND

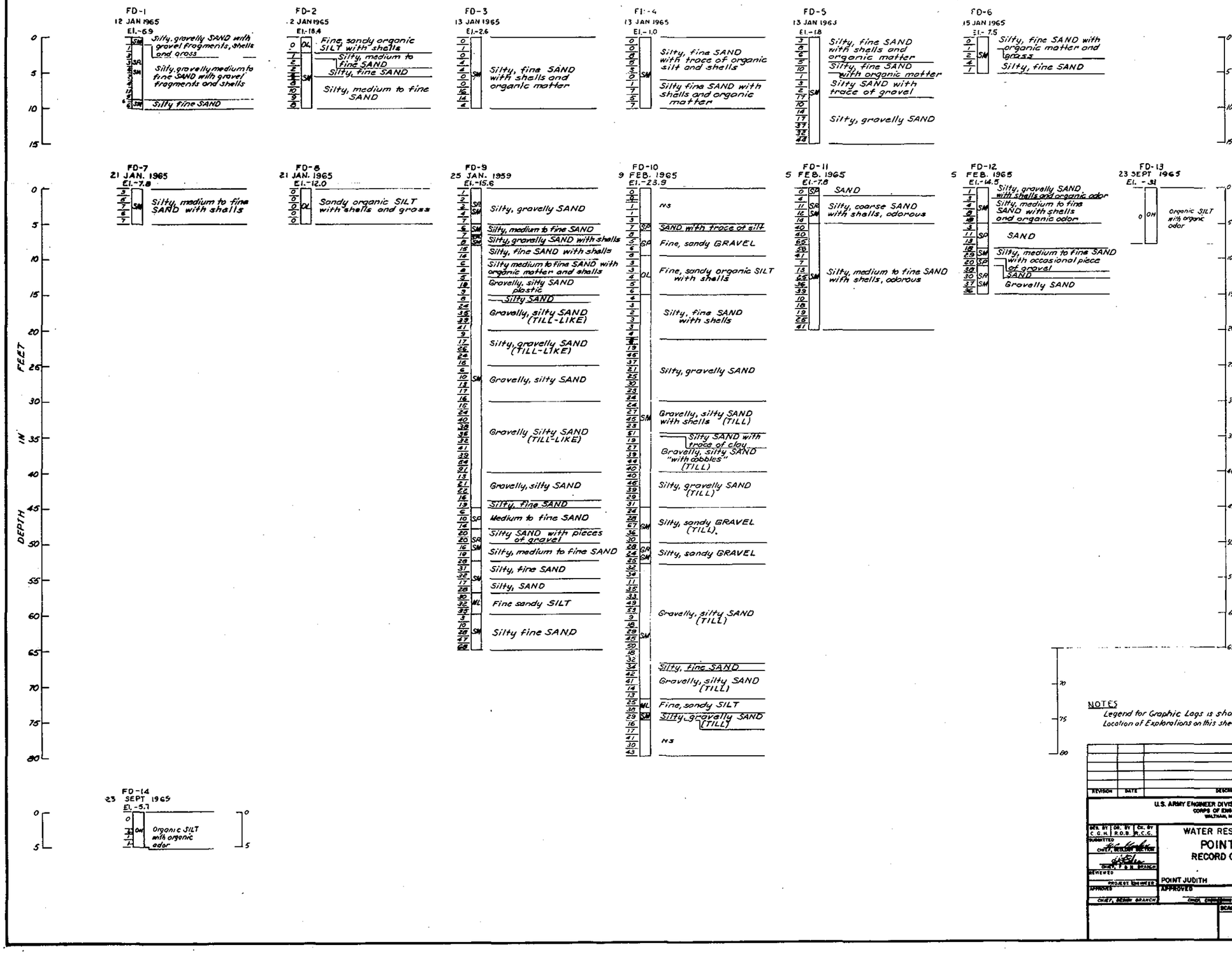
DATE MARCH 1966

SCALE AS SHOWN | SPEC. NO CIV. ENG.-19-066

DRAWING NUMBER

SHEET

PLATE NO. 2-17



NOTES

Legend for Graphic Logs is shown on Plate No. 2-17

Location of Explorations on this sheet appear on Plate No. 2-16

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.G.H. | DR. BY R.D.B. | CH. BY R.C.G.

SUBMITTED
CHIEF, ENGINEERING DIVISION

CHIEF, P & D BRANCH

REVIEWED
PROJECT ENGINEER

APPROVED
CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT

POINT JUDITH, R.I.
RECORD OF EXPLORATIONS NO. 2

POINT JUDITH RHODE ISLAND

APPROVED DATE MARCH 1966

CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN | SPEC. NO CIV. ENG.-19-065

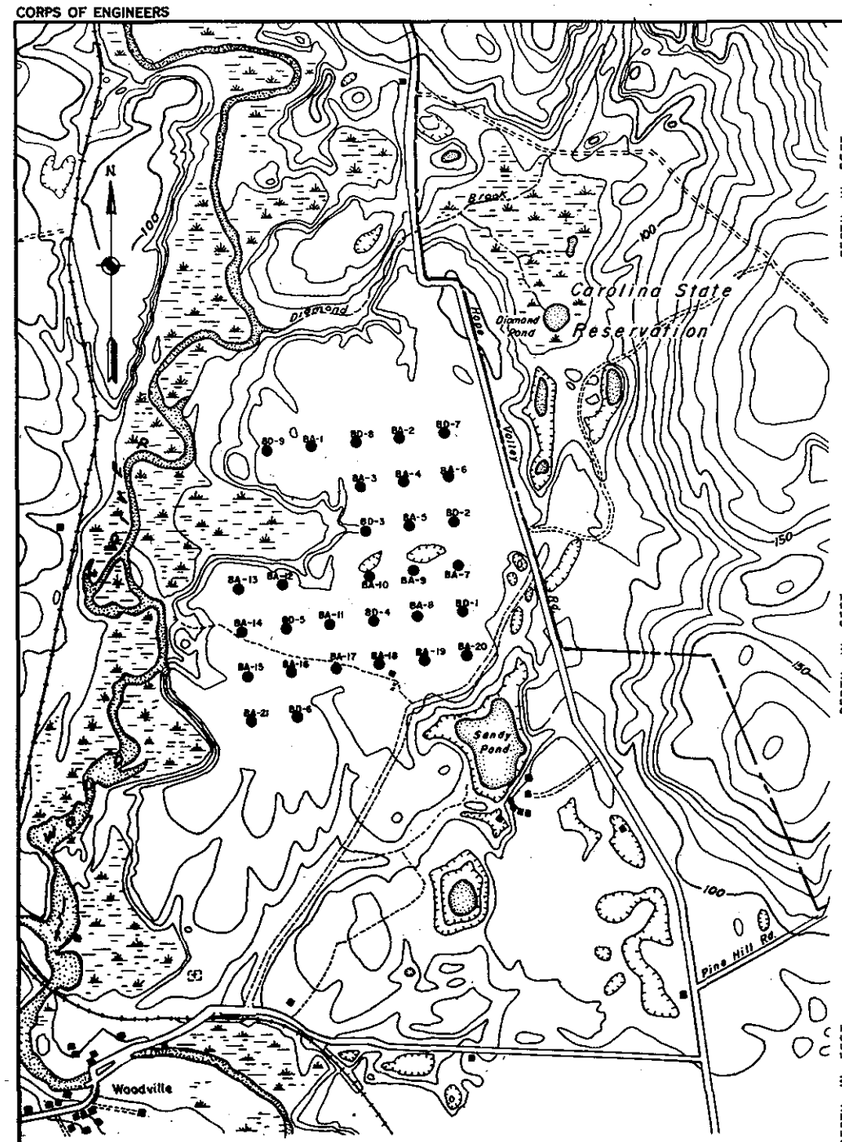
DRAWING NUMBER

SHEET

PLATE NO. 2-18

CORPS OF ENGINEERS

U. S. ARMY

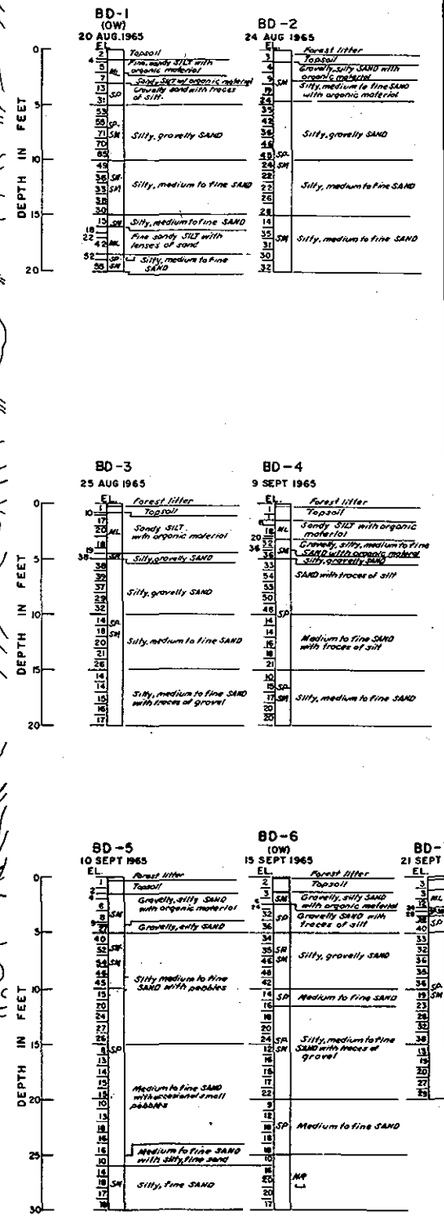


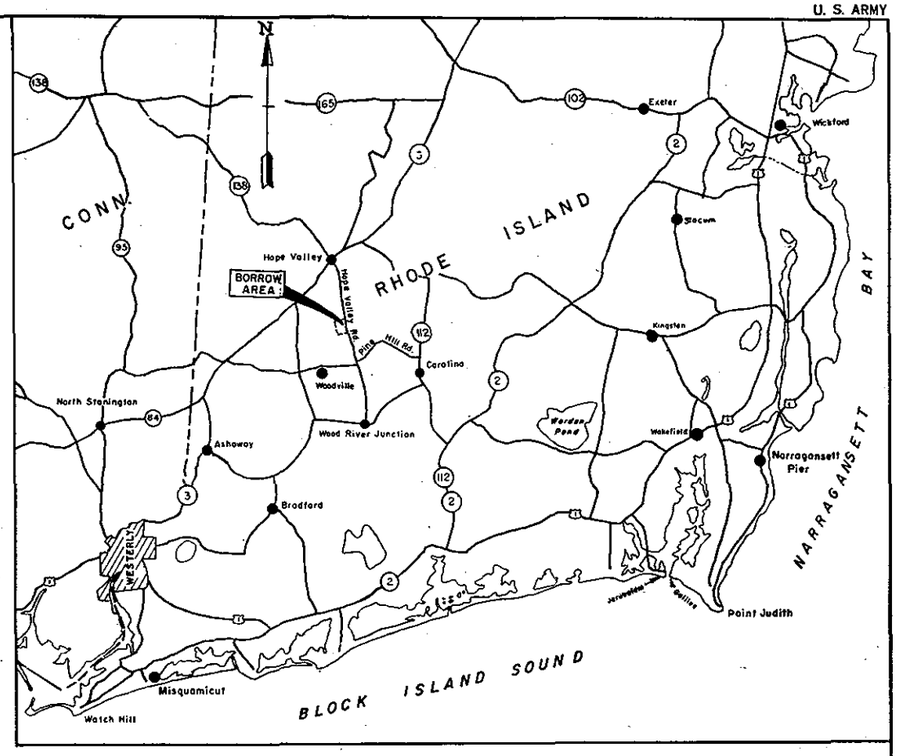
PLAN

1000' 0 1000'

SCALE

CONTOUR INTERVAL IS 10 FEET





LOCATION MAP

5 0 5 Miles

SCALE

LEGEND FOR GRAPHIC LOGS

BA, BD (OW) — Borrow Auger Boring & Borrow Test Boring; Observation well installed

1 AUG 1965 — Date exploration completed

EL. — Elevation of ground surface at time of exploration

SP / 35 / NR — Group letter symbol according to Unified Soil Classification System; Number of blows per foot of penetration using a 300-350 pound hammer falling freely on average of 18 inches on a standard sample spoon equipped with a beveled and sharpened drive shoe. No recovery or unsatisfactory soils samples recovered.

Bottom of observation well

Subsurface water level was not encountered.

NOTE

Logs of BA's are shown on Record of Borrow Explorations, No. 2

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK. BY
C G H	R & W	R C G

SUBMITTED — CHIEF, DESIGN SECTION

REVIEWED — CHIEF, P & M BRANCH

PROJECT ENGINEER

APPROVED — CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT

POINT JUDITH, R.I.

PLAN AND RECORD OF BORROW EXPLORATIONS NO.1

POINT JUDITH — RHODE ISLAND

APPROVED — CHIEF, ENGINEERING DIVISION — DATE MARCH 1966

SCALE AS SHOWN | SPEC. NO CIV. ENG. - 19-016

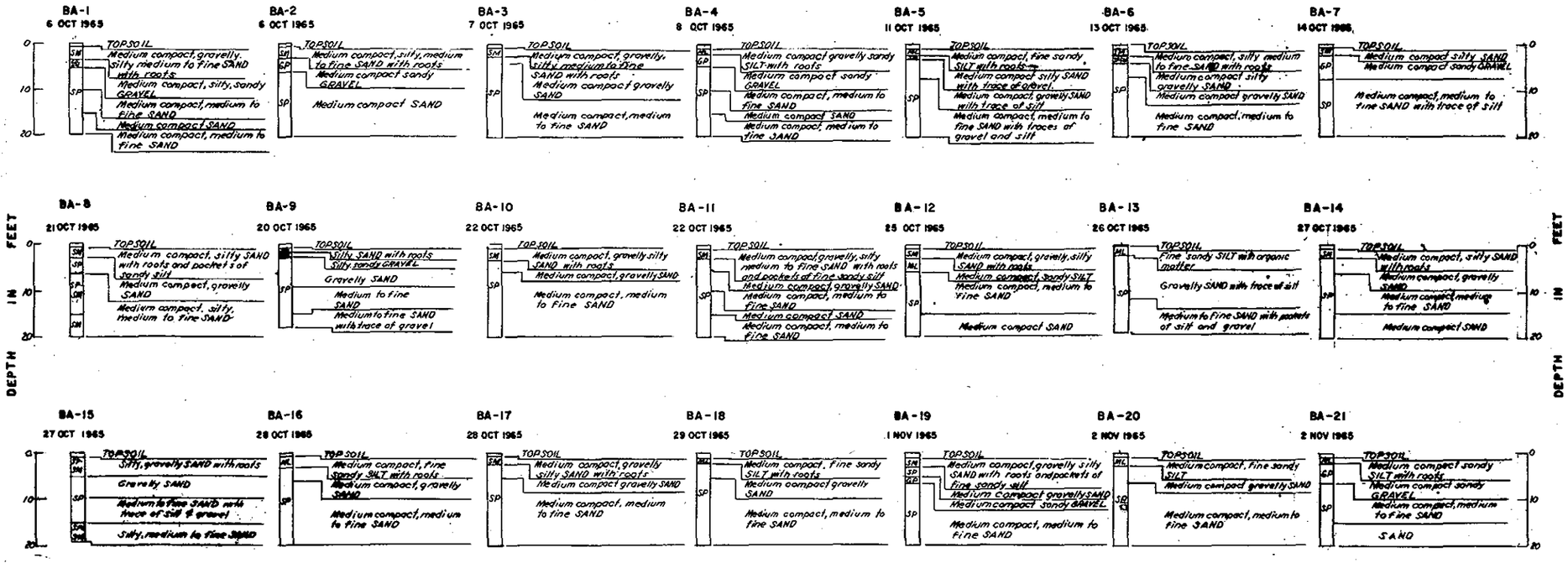
DRAWING NUMBER

SHEET

PLATE NO. 2-19

CORPS OF ENGINEERS

U. S. ARMY



NOTE.

Locations of Explorations and Legend for Graphic Logs are shown on Plate No. 2-19

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY C.G.H. | DR. BY R.A.M. | CK. BY R.C.G.

SUBMITTED
CHIEF, ENGRG. DIV.

REVIEWED
PROJECT ENGINEER

APPROVED
CHIEF, ENGRG. BRANCH

WATER RESOURCES DEVELOPMENT
POINT JUDITH, R.I.
RECORD OF BORROW EXPLORATIONS NO. 2

POINT JUDITH — RHODE ISLAND

APPROVED
CHIEF, ENGINEERING DIVISION

DATE MARCH 1966

SCALE AS SHOWN | SPEC. NO CIV. ENG. - 19 - 065

DRAWING NUMBER

SHEET

PLATE NO. 2-20

Explor. No.	Depth Range (Feet)	TOTAL SAMPLE Percent Gravel	Percent Silt/Clay	M_d	Q_3	Q_1	S_o	SAND FRACTION ONLY M_d	Q_3	Q_1	S_o
BD-1	3.0- 5.0	13	3	0.57	1.75	0.33	2.30	0.47	0.93	0.30	1.76
	5.0-10.0	27	7	1.10	4.80	0.42	3.38	0.60	1.40	0.32	2.09
	10.0-15.0	0	8	0.40	0.70	0.23	1.75				
	15.0-16.1	0	13	0.32	0.63	0.18	1.87				
	16.5-18.5	0	53		0.10						
	18.5-20.0	0	8	0.38	0.50	0.13	1.96				
BD-2	5.0-10.0	16	10	0.55	1.75	0.25	2.65	0.43	1.15	0.21	2.34
	10.0-15.0	8	9	0.37	0.80	0.21	1.95	0.34	0.61	0.19	1.84
	15.0-20.0	9	14	0.29	0.70	0.15	2.16	0.26	0.49	0.13	1.94
BD-3	5.0-10.0	18	6	0.73	2.80	0.37	2.75	0.54	1.20	0.32	1.94
	10.0-15.0	9	8	0.48	0.92	0.28	1.81	0.43	0.70	0.25	1.68
	15.0-20.0	0	7	0.38	0.61	0.22	1.71				
BD-4	5.0-10.0	7	4	0.54	1.30	0.28	2.16	0.48	0.97	0.26	1.93
	10.0-15.0	1	2	0.37	0.67	0.23	1.71				
	15.0-20.0	0	12	0.27	0.48	0.27	1.68				
BD-5	5.0-10.0	6	7	0.43	0.79	0.24	1.82	0.40	0.67	0.23	1.71
	10.0-15.0	2	8	0.38	0.80	0.18	2.11				
	15.0-20.0	3	3	0.39	0.66	0.18	1.91				
	20.0-25.0	1	2	0.38	0.54	0.25	1.47				
	26.0-30.0	0	32	0.12	0.15						
BD-6	2.5- 5.0	17	2	1.20	3.00	0.46	2.52	0.79	1.85	0.40	2.15
	5.0-10.0	18	7	0.93	3.25	0.35	3.05	0.57	1.70	0.28	2.47
	11.5-15.0	0	6	0.38	0.63	0.23	1.66				
	15.0-20.0	0	8	0.24	0.35	0.17	1.44				
	20.0-25.0	1	3	0.26	0.39	0.19	1.43				
BD-7	3.5- 5.0	32	3	1.1	6.7	0.36	4.32	0.50	1.3	0.27	2.19
	5.0-10.0	28	6	0.78	0.57	0.31	1.36	0.44	0.98	0.22	2.11
	10.0-15.0	17	8	0.58	2.3	0.26	2.97	0.42	0.99	0.22	2.12
	15.0-20.0	0	7	0.39	0.58	0.23	1.59				
BD-8	3.6- 5.0	18	6	1.1	3.2	0.42	2.76	0.77	1.6	0.35	2.14
	5.0-10.0	18	7	0.72	2.7	0.32	2.90	0.52	1.2	0.26	2.15
	10.0-15.0	0	5	0.42	0.77	0.24	1.79				
	15.0-20.0	1	10	0.39	0.83	0.18	2.15				
	20.0-25.0	10	6	0.53	1.2	0.31	1.97	0.37	0.81	0.28	1.70
	25.0-30.0	7	8	0.73	1.7	0.33	2.27	0.67	1.3	0.31	2.05
BD-9	6.5-10.0	18	6	0.48	2.8	0.21	3.66	0.40	0.93	0.17	2.34
	10.0-15.0	3	6	0.43	0.88	0.24	1.91				
	15.0-20.0	3	7	0.35	0.64	0.19	1.84				

Explor. No.	Depth Range (Feet)	TOTAL SAMPLE Percent Gravel	Percent Silt/Clay	M_d	Q_3	Q_1	S_o	SAND FRACTION ONLY M_d	Q_3	Q_1	S_o
BA-1	5.4-10.0	6	1	0.56	1.3	0.30	2.08	0.50	0.99	0.28	1.88
	10.0-15.0	6	0	0.60	1.4	0.33	2.06	0.53	1.2	0.31	1.97
	15.0-20.0	4	1	0.48	0.98	0.35	1.68	0.45	0.87	0.33	1.63
BA-2	6.2-10.0	7	1	0.73	1.8	0.27	2.64	0.67	1.5	0.24	2.50
	10.0-15.0	6	1	0.59	1.4	0.32	2.09	0.53	1.2	0.29	2.03
	15.0-20.0	8	1	0.76	1.8	0.37	2.21	0.66	1.5	0.34	2.10
BA-3	4.4-10.0	0	1	0.43	0.74	0.28	1.63				
	10.0-15.0	3	1	0.40	0.76	0.23	1.82				
	15.0-20.0	2	1	0.50	0.94	0.28	1.83				
BA-4	4.8-10.0	7	1	0.57	1.2	0.36	1.82	0.52	0.90	0.33	1.65
	10.0-15.0	5	1	0.57	1.4	0.34	2.03	0.52	1.2	0.32	1.94
	15.0-20.0	4	2	0.57	1.2	0.32	1.94	0.52	1.0	0.30	1.82
BA-5	3.3- 7.5	26	2	1.3	5.3	0.58	3.02	0.80	1.5	0.46	1.81
	7.5-10.0	2	2	0.46	0.87	0.27	1.80				
	10.0-15.0	8	1	0.60	1.3	0.33	1.99	0.56	1.0	0.31	1.80
	15.0-20.0	2	3	0.53	0.99	0.28	1.88				
BA-6	2.3- 4.1	18	6	0.61	2.4	0.38	1.59	0.49	0.92	0.33	1.67
	4.1- 7.0	24	2	0.99	4.3	0.62	2.63	0.74	2.4	0.52	1.64
	7.0-10.0	0	1	0.49	0.91	0.33	1.66				
	10.0-15.0	0	2	0.42	0.73	0.24	1.75				
	15.0-20.0			0.39	0.70	0.22	1.78				
BA-7	2.4- 5.5	51	1	4.8	13.	1.3	3.16	0.92	2.0	0.58	1.86
	5.6- 7.7	57	1	6.5	14.	1.6	2.96	1.1	2.7	0.74	1.91
	7.7-10.0	0	1	0.41	0.57	0.26	1.48				
	10.0-15.0	0	2	0.39	0.57	0.29	1.40				
	15.0-20.0	0	2	0.37	0.53	0.24	1.49				
BA-8	3.1- 6.5	49	1	4.3	13.	1.0	3.61	1.1	2.3	0.48	2.19
	6.5-10.0	2	7	0.45	0.78	0.18	2.08				
	10.0-15.0	0	8	0.39	0.66	0.17	1.97				
	15.0-20.0	0	13	0.25	0.60	0.09	2.58				
BA-9	3.0- 6.0	27	1	1.6	5.1	0.71	2.68	1.0	1.9	0.58	1.81
	6.0- 9.5	12	1	0.84	1.7	0.53	1.79	0.74	1.2	0.47	1.60
	9.5-15.0	0	1	0.57	0.91	0.38	1.55				
	15.0-18.0	2	3	0.23	0.34	0.17	1.13				
BA-10	3.4- 5.9	45	1	3.5	12.	0.70	4.14	0.77	1.8	0.43	2.05
	5.9-10.0	6	1	0.66	1.2	0.40	1.73	0.60	0.98	0.37	1.63
	10.0-15.0	7	1	0.54	1.3	0.31	2.05	0.50	0.94	0.30	1.77
	15.0-20.0	5	1	0.59	1.1	0.37	1.73	0.56	0.94	0.35	1.64
BA-11	2.9- 5.5	21	1	1.3	4.1	0.55	2.73	0.90	1.8	0.47	2.96
	5.5-10.0	0	1	0.67	1.0	0.40	1.58				
	10.5-15.0	8	1	0.70	1.5	0.39	1.96	0.62	1.2	0.36	1.82
	15.0-20.0	4	1	0.61	1.2	0.39	1.75				

Explor. No.	Depth Range (Feet)	TOTAL SAMPLE Percent Gravel	Percent Silt/Clay	M_d	Q_3	Q_1	S_o	SAND FRACTION ONLY M_d	Q_3	Q_1	S_o
BA-12	6.0-10.0	3	2	0.60	1.3	0.37	1.88				
	10.0-15.0	3	3	0.57	0.98	0.34	1.70				
	15.0-20.0	4	1	0.63	1.4	0.39	1.90				
BA-13	2.4- 5.0	29	2	1.3	5.7	0.48	3.44	0.70	1.5	0.39	1.96
	5.0- 7.5	22	1	1.2	4.0	0.46	2.95	0.68	1.7	0.40	2.06
	7.5-10.0	14	1	0.65	1.6	0.45	1.88	0.56	0.89	0.43	1.47
	11.8-15.0	0	1	0.38	0.74	0.24	1.76				
	15.0-20.0	0	2	0.31	0.56	0.19	1.72				
BA-14	2.9- 6.3	23	1	1.1	5.0	0.50	3.16	0.74	1.4	0.41	1.85
	6.5-10.0	3	2	0.57	0.97	0.34	1.69				
	10.0-15.0	4	1	0.67	1.3	0.36	1.90				
	15.0-20.0	5	1	0.74	1.5	0.44	1.85				
BA-15	0.9- 5.1	24	9	0.63	4.7	0.30	3.95	0.43	0.84	0.21	2.00
	5.1- 9.8	43	2	3.0	9.8	0.58	4.16	0.59	1.7	0.36	2.17
	9.8-15.0	2	4	0.49	0.80	0.32	1.58				
	15.0-19.0	0	7	0.43	0.63	0.28	1.50				
BA-16	3.2- 6.2	17	1	0.79	2.4	0.40	2.45	0.60	1.3	0.34	1.95
	6.2-10.0	4	1	0.47	0.80	0.28	1.67				
	10.0-15.0	0	1	0.47	0.74	0.27	1.66				
	15.0-20.0	0	1	0.42	0.69	0.28	1.57				
BA-17	2.3- 5.3	23	1	0.75	1.8	0.47	1.96	0.67	1.3	0.43	1.74
	5.3-10.0	5	2	0.52	1.2	0.33	1.91				
	10.0-15.0	5	1	0.58	1.0	0.33	1.74				
	15.0-20.0	0	2	0.42	0.73	0.27	1.64				
BA-18	2.2- 5.5	25	3	0.63	4.8	0.31	3.94	0.42	0.84	0.28	1.73
	5.5-10.0	0	2	0.42	0.67	0.28	1.55				
	10.0-15.0	0	3	0.46	0.71	0.27	1.62				
	15.0-20.0	8	1	0.50	0.91	0.35	1.61				
BA-19	6.5-10.0	3	1	0.50	1.0	0.31	1.80				
	10.0-15.0	3	1	0.50	1.1	0.30	1.91				
	15.0-20.0	0	0	0.50	0.95	0.30	1.78				
BA-20	2.8- 6.4	23	1	1.3	4.0	0.59	2.61	0.82	1.7	0.50	1.85
	6.4-10.0	4	2	0.41	0.79	0.28	1.68				
	10.0-15.0	6	3	0.45	0.95	0.29	1.81				
	15.0-20.0	0	2	0.39	0.60	0.27	1.49				
BA-21	6.5-10.0	0	0	0.50	0.94	0.28	1.85				
	10.0-15.0	0	0	0.56	1.0	0.33	1.74				
	15.0-20.0	0	1	0.56	1.2	0.31	1.97				

LEGEND

BD — Borrow test boring

BA — Borrow auger boring

M_d — Median diameter (mm)

Q_3 — 75th percentile passing size (mm)

Q_1 — 25th percentile passing size (mm)

S_o — Sorting coefficient (geometric quartile deviation)

NOTES

Plan and logs of explorations are on Plates 2-19 and 2-20.

Depth range is measured from ground surface.

Sand fraction is analyis recalculated on basis of material passing No.4, U.S. Standard sieve and includes fines.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CH. BY
C.G.M.	L.M.I.	R.C.G.

SUBMITTED
CHIEF, GEOLOGY SECTION
CHIEF, F & H BRANCH
REVIEWED
PROJECT ENGINEER
APPROVED
CHIEF, DESIGN BRANCH

WATER RESOURCES DEVELOPMENT
POINT JUDITH, R.I.
GRAIN SIZE PARAMETERS OF BORROW MATERIALS

POINT JUDITH — RHODE ISLAND

APPROVED — DATE MARCH 1966
CHIEF, ENGINEERING DIVISION

SCALE

SPEC. NO CIV. ENG.-19-016

DRAWING NUMBER

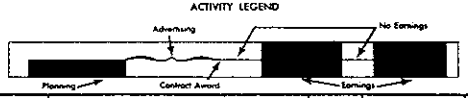
SHEET

PLATE NO. 2-21

APPROPRIATION TITLE: Construction, General
CLASSIFICATION: LOCAL PROTECTION, (FLOOD CONTROL)

PROJECT: POINT JUDITH, RHODE ISLAND

ACTIVITY LEGEND



DETAILED PROJECT SCHEDULE (PB-2A)

(TO BE REPORTED IN THOUSANDS OF DOLLARS)

LINE NO.	COST ACCOUNT NO.	ITEM	CONT. TYPE & NO.	QUANTITY SIZE, OR CAPACITY; DATE OF AWARD (As Applicable)	PROJECT COST ESTIMATE	TOTAL AS OF JUNE 30, 1966 (Est)	CURRENT FISCAL YEAR 19 67 TOTAL	CURRENT FISCAL YEAR 19 67 QUARTERS 1st	2nd	3rd	4th	BUDGET FISCAL YEAR 19 68 TOTAL	BUDGET FISCAL YEAR 19 68 QUARTERS 1st	2nd	3rd	4th	FUTURE FISCAL YEARS 19 69	19 70	19	BALANCE TO COMPLETE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1	01.	LANDS AND DAMAGES			985.0							385.0		85.0	150.0	150.0	300.0	300.0		
2																				
3	09.	CHANNELS & CANALS	L.S.	9/68	640.0												640.0			
4																				
5	11.	LEVEES AND FLOODWALLS	c.c.	12/67	4,600.0							640.0			240.0	400.0	1,660.0	2,300.0		
6																				
7	30.	ENGINEERING & DESIGN			447.0	163.0	136.0	31.0	30.0	30.0	45.0	88.0	30.0	29.0	9.0	20.0	30.0	30.0		
8																				
9	31.	SUPERVISION & ADMINISTRATION			428.0	17.0	14.0	3.0	3.0	3.0	5.0	57.0	3.0	3.0	21.0	30.0	170.0	170.0		
10																				
11		TOTAL APPLIED COST (Fed Funds & Non-Fed Contrib)			7,100.0	180.0	150.0	34.0	33.0	33.0	50.0	1,170.0	33.0	117.0	420.0	600.0	2,800.0	2,800.0		
12		Undistributed Cost (None)																		
13		TOTAL PROJECT COST (Fed Funds & Non-Fed Contrib)			7,100.0	180.0	150.0	34.0	33.0	33.0	50.0	1,170.0	33.0	117.0	420.0	600.0	2,800.0	2,800.0		
14		Pending Adjustments																		
15		TOTAL COST (Federal Funds & Non-Federal Contributions)			7,100.0	180.0	150.0					1,170.0					2,800.0	2,800.0		
16																				
17		FEDERAL FUNDS																		
18		TOTAL COST			4,900.0	180.0	150.0	34.0	33.0	33.0	50.0	580.0	33.0	32.0	195.0	320.0	2,000.0	1,990.0		
19		NON-FEDERAL CONTRIBUTIONS																		
20	-	TOTAL COST 31%			2,200.0	0	0					590.0		85.0	225.0	280.0	800.0	810.0		
21		Undelivered Orders																		
22		TOTAL OBLIGATIONS (Federal Funds & Non-Fed Contrib)				180.0	150.0					1,170.0					2,800.0	2,800.0		
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				

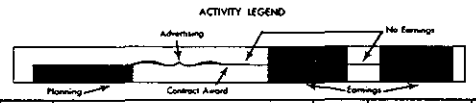
EFFECTIVE DATE: 1 JULY 1966 | DIVISION: NEW ENGLAND | DISTRICT | BASIN: NEW ENGLAND | PREPARED: POINT JUDITH, RHODE ISLAND

ENG FORM 2293

PLATE NO. 22-2

APPROPRIATION TITLE: Construction, General
CLASSIFICATION: LOCAL PROTECTION (FLOOD CONTROL)

PROJECT: POINT JUDITH, RHODE ISLAND



DETAILED PROJECT SCHEDULE (PB-2A)

(TO BE REPORTED IN THOUSANDS OF DOLLARS)

LINE NO.	COST ACCOUNT NO.	ITEM	CONT. TYPE & NO.	QUANTITY SIZE, OR CAPACITY; DATE OF AWARD (As Applicable)	PROJECT COST ESTIMATE	TOTAL AS OF JUNE 30, 19 66 (Est)	CURRENT FISCAL YEAR 19 67 TOTAL	CURRENT FISCAL YEAR 19 67 QUARTERS 1st	2nd	3rd	4th	BUDGET FISCAL YEAR 19 68 TOTAL	BUDGET FISCAL YEAR 19 68 QUARTERS 1st	2nd	3rd	4th	FUTURE FISCAL YEARS 19 69	19 70	19	BALANCE TO COMPLETE
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1		METHOD OF FINANCING																		
2		FEDERAL FUNDS																		
3		APPROPRIATIONS				310.0	100.0													
4		UNOBLIG. CARRYOVER FROM PRIOR YEAR					130.0					80.0								
5		TOTAL FUNDS AVAILABLE FOR OBLIGATION					230.0										2,000.0	1,990.0		
6		APPROPRIATION REQUIRED										500.0								
7																				
8		NON-FEDERAL CONTRIBUTIONS																		
9		CONTRIBUTIONS			1,215.0												300.0	300.0		
10		LANDS AND DAMAGES			985.0							385.0								
11		UNOBLIG. CARRYOVER FROM PRIOR YEAR																		
12		TOTAL FUNDS AVAILABLE FOR OBLIGATION															500.0	510.0		
13		CONTRIBUTION REQUIRED										205.0								
14																				
15																				
16																				
17																				
18																				
19																				
20																				
21																				
22																				
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				

EFFECTIVE DATE: 1 JULY 1966 | DIVISION: NEW ENGLAND | DISTRICT | BASIN: NEW ENGLAND | PROJECT: POINT JUDITH, RHODE ISLAND

ENG FORM 2201a 1 JAN 65 REPLACES EDITION OF 1 JUL 64, WHICH MAY BE USED. (EM 11-2-101) (TRANSLUCENT)

PLATE NO. 23-2